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7. —— "On Abnormal Veins in the Frog." Jour. Anat. Physiol. vols. xiv. & xv., n. s.
8. —— & Jones.—"On the Structure of the Vertebrate Liver." Jour. Physiol. vol. x., 1889.
9. —— "Notes on the Origin of the Liver." Jour. Anat. Physiol. vol. v. n. s., 1891.
10. Woodland, W.—"On a New Mode of Persistence of the Posterior Cardinal Vein in the Frog (*Rana temporaria*): with a Suggestion as to the Phylogenetic Origin of the Post-Caval Vein." Zool. Anzeig. vol. xxviii., 1905.
11. —— "On the Phylogenetic Cause of the Transposition of the Testes in Mammalia." Proc. Zool. Soc. Lond. 1903, vol. i. pp. 319–335.

December 11, 1906.

Dr. Henry Woodward, F.R.S., Vice-President, in the Chair.

The Secretary exhibited a black-and-white sketch of a young female Gorilla (Pl. LXIII.), made by Mr. Carton Moore-Park, R.B.A., F.Z.S., from an animal that had lived for a few weeks in the Society's Gardens in 1906. He stated that most of the published figures of Gorillas appeared to represent more adult animals. Young Gorillas were much more human, and more gentle and intelligent than was generally supposed.

Mr. H. B. Fantham, B.Sc., F.Z.S., exhibited original drawings of "*Trypanosoma*" *balbianii* (Certes), showing apparent cilia, which might, however, be only threads of the sheath or undulating membrane which had become ruptured. These were first seen in this organism by M. Fred Vlès and himself at Roscoff this summer. This parasite, which occurs in the crystalline style of the Oyster, was compared with various Spirilla and Spirochætes, and its systematic position among the Protista was discussed.

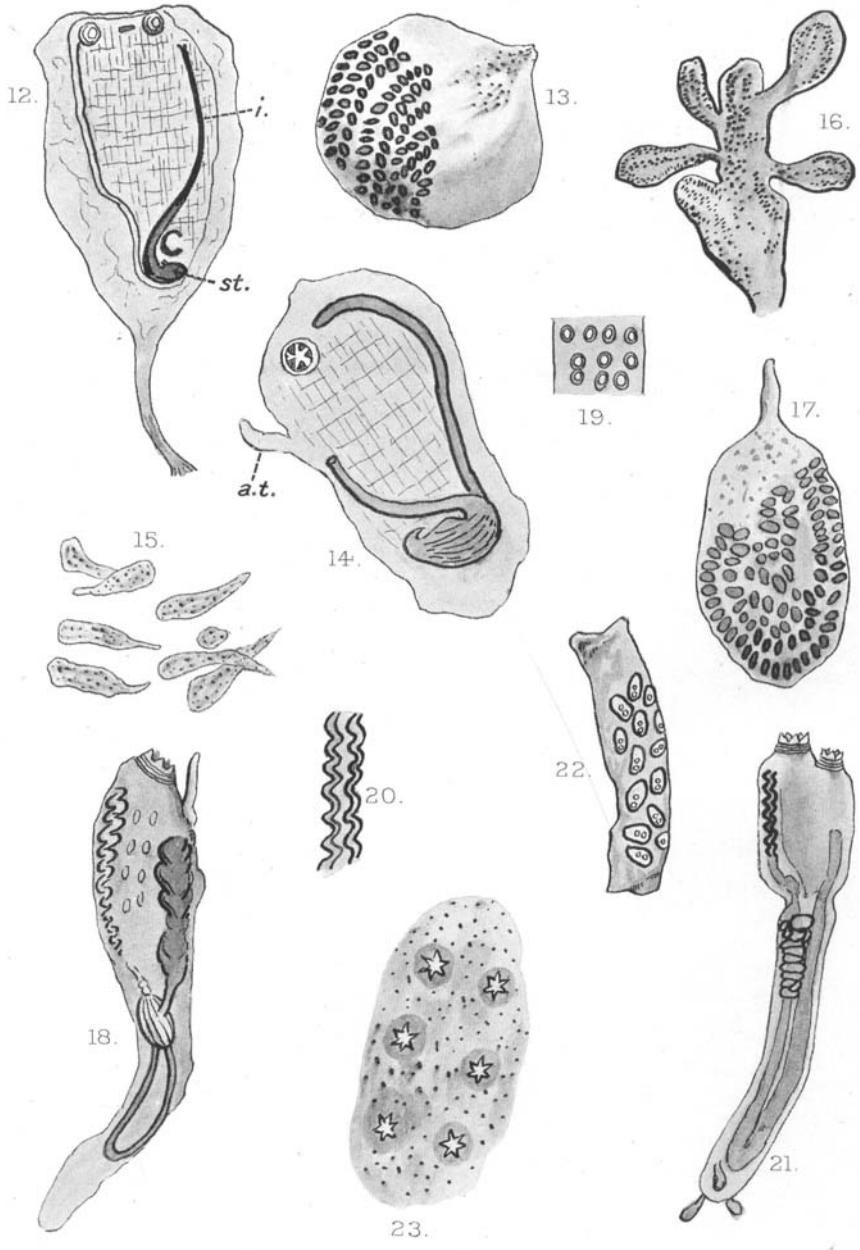
Mr. F. E. Beddard, F.R.S., F.Z.S., exhibited and made remarks upon some examples of the Earthworm (*Benhamia johnstoni*) from Mt. Ruwenzori, which had been entrusted to him for study by Mr. W. R. Ogilvie-Grant.

Mr. J. L. Bonhote, F.Z.S., exhibited one of the innermost secondaries of the Knot (*Tringa canutus*) taken from a bird in his aviaries. The specimen was remarkable from the fact that the summer feather, instead of being cast at the autumn moult, was

continuous with the new autumn feather; it did not merely adhere to the tip of this latter, but the shaft was continuous and the barbs were forming at the proximal extremity; the white tip of the winter feather formed also the light base of the summer feather. The summer feather was rather shorter than in the normal condition, and possibly was not fully grown when the autumn moult intervened.

Mr. R. I. Pocock, F.Z.S., Superintendent of the Gardens, exhibited the rattle formed of modified quills in the tail of a Porcupine, *Hystrix cristata*, and pointed out that the organ must be classed functionally in the same category as the rattle of the Rattlesnake and the stridulating organs of some Scorpions and large Spiders, that is to say, its use was aposematic. He continued as follows:—The behaviour of Porcupines at night when prowling abroad is quite different from that of most nocturnal animals. Instead of being silent in their movements like the latter, they seem to make as much noise as possible, rattling their quills and uttering hoarse guttural grunts, both of which sounds can be heard at a considerable distance. Their proximity is also advertised in another way, namely, by the whiteness of their quills, which when erected in the characteristic fan-like manner are quite conspicuous in the dark and enable the observer to locate the animal accurately, which the crepitation of the quills alone is incapable of doing. Warning or aposematic attributes are characteristic of poisonous or nauseous animals which nevertheless may be readily killed or damaged by the attack of more powerful animals ignorant of the protective attributes of their prey, and of the risk of injury they themselves run in attempting to seize it. Porcupines, in spite of their spiny armature, are easy to kill on account of the extreme thinness of the skin which can be torn to shreds with the greatest facility. A dog trained to the work will shake one to pieces in a few seconds when he has once taken hold below or in front of the spiny area, as Mr. Pocock has been informed by Mr. Simons, one of the collectors employed in S. Africa by Col. Sloggett, D.S.O., F.Z.S. This correlation between the defensive spine armature and the facile destructibility of Porcupines accounts, on the theory of aposemasy, for the advertising characteristics of the animals.

The same explanation must be extended to the Brush-tailed Porcupines (*Atherura*), of Africa and India, which also possess rattles formed of modified quills on their tails and display a conspicuous white blaze by elevating the spines on the lumbar area of the back. On the other hand, the North-American Porcupine (*Erethizon*), and the prehensile-tailed South and Central-American species (*Coendu*), which are without the rattle but have the spines thickly interspersed with hairs, are known to be procryptically coloured amongst the branches and foliage of trees. When, however, the animals are disturbed they raise their spines and become visible at once by the display of the white or red colour at their



ASCIDIANS FROM CAPE VERDE.

bases near the skin. A similar combination of procryptic coloration when at rest and of aposematic coloration when disturbed, is shown by the large Indian Mygaloid Spider *Pœcilotheria* and by many of the Lycosidæ *.

The above-mentioned facts and theories are based upon observations of the Porcupines that have lived during the past three years in the Society's Gardens.

Dr. C. G. Seligmann, F.Z.S., exhibited two skulls of male Domestic Sheep, and made the following remarks:—The two heads shown contrast the form of skull of the normal ram of the Herdwick breed (in which only the males have horns) and a ram of the same age and breed castrated in infancy. The skull of the castrated sheep or wether is less rugged and the bones thinner, but besides such general differences and the obvious absence of horns the plane of the os frontis is continued backwards behind the orbits at a very obtuse angle. In the skull of the normal ram the plane of the frontal behind the orbit lies almost at right angles with the interorbital portion of the bone, the horn-cores arising from the upper or horizontal area. Although the skull generally is thicker in the normal ram than in the wether, this alone does not account for the difference in external form, seeing that the cranial cavity presents a corresponding extension in the frontal region. It is worth noting that the conformation of the skull of the castrated animal resembles that of the hornless ewe of the breed.

The following papers were read:—

1. On Collections of the Cape Verde Island Marine Fauna, made by Cyril Crossland, M.A. (Cantab.), B.Sc. (Lond.), F.Z.S., of St. Andrews University, July to September 1904.—THE ASCIDIANS. By JOHN RENNIE, D.Sc., and HARRY WISEMAN, M.A., B.Sc., University of Aberdeen.†

[Received October 12, 1906.]

(Plates LXIV. & LXV.‡)

This memoir deals with the Ascidians collected by Mr. Crossland at Cape Verde in the year 1904. Although a fairly abundant supply of material was secured, it has not proved particularly rich in species. In all, examples of only ten forms were collected, two of which appear to be new to science. Notes regarding localities are meagre; most of the specimens appear to have been obtained at Mattiota, St. Vincent Harbour.

* See Pocock, Ann. Mag. Nat. Hist. (7) iii. p. 84, 1899.

† The expenses of Mr. Crossland's collecting trip were borne by the Carnegie Trustees.

‡ For explanation of the Plates see p. 910.

Description of Species.

TUNICATA Lamarck, 1816.

Order I. ASCIDIACEA Blv. 1827.

Sub-Order 1. **Ascidiæ Simplices.**

Family HALOCYNTHIIDÆ Verrill, 1879.

(*Cynthiidæ* Savigny, 1816.)

HALOCYNTHIA RUBRILABIA Verrill. (Plate LXIV. figs. 1–6 & 8.)

This species was represented by a fair number of specimens, the external characters of which agree well with previous descriptions. The four-lobed branchial and atrial apertures are conspicuous. The average height is 34 mm., width 22 mm. The reddish test is conspicuous only in a few specimens, most appearing of a dull dirty white colour. The inner surface of the test is smooth and glistening. The mantle is very thin except where the muscular strands are present. These are very numerous and exhibit a regular arrangement, the longitudinal bands radiating excentrically from near the atrial opening (fig. 5) and forming a network over the branchial sac (fig. 1). Of some interest is the fact that the tentacles are compound, presenting some degree of complexity (fig. 2). Van Name's specimens from Bermuda were "simply pinnate . . . . and of various sizes." We observed none in this species which could be so described. The dorsal tubercle shows a pair of well-curved horns (fig. 3). The ovary is yellowish in colour; the testes are pale and club-shaped. These glands form a double row on both sides of the animal, and in most cases the serial arrangement is very noticeable (figs. 4 and 5).

Locality. Attached to bottom of lighter, St. Vincent Harbour. Formerly recorded from Bermuda, adherent to stones, shells, corals, &c., common in shallow water.

STYELA PARTITA Stimpson. (Plate LXIV. figs. 7 & 9.)

Several examples of this species were found. From earlier accounts (Verrill, Van Name) it is evidently very variable in all parts of its range. The Cape Verde examples agree well with Van Name's description of Wood's Hole specimens. Mr. Crossland supplies a note that externally they were "yellow on a dark brown ground." At Bermuda they are, according to Van Name, "more or less reddish or brownish yellow, or greyish yellow, becoming brown or red on the upper surface, especially about the siphons." Verrill's "alternate striping of red and white in the apertures" has not been observed in the present examples. They measure about 43 mm. long and 26 mm. wide. The test is coriaceous, varying from 2 to 4 mm. in thickness. It is roughest around the apertures. The number of tentacles is about sixteen, and they appear uniform in size. These, however, according to Van Name, are variable characters depending upon size and age.

He has observed from about 30 to 50 and of different sizes. The dorsal tubercle (fig. 9) is elevated and horseshoe-shaped. The horns are simple and only slightly inturned. The gonad of the left side of the body is larger than that of the right. The ovary is a sinuous coil of pale colour; the testes are numerous and club-shaped.

Family Ascidiidæ Herdm. 1880.

Ascidia obliqua Alder. (Plate LXIV. figs. 10 & 11.)

External appearance.—The shape is oval, the anterior end being rather narrower than the posterior rounded surface. The body is somewhat compressed laterally and is attached by the posterior half of the left side. A terminal branchial aperture with 8 lobes and an atrial opening with 6 lobes are both present on the dorsal edge. The general colour is light grey.

Dimensions of specimens measured:—

	1.	2.	3.
Length	3·2 cm.	2·9 cm.	2·5 cm.
Breadth.....	1·4 cm.	1·6 cm.	1·4 cm.

The test is gelatinous and translucent. A marked U-shaped fold is very characteristic of the right side (fig. 10).

The branchial sac has no longitudinal folds, is very tough and not easily torn. Narrow transverse vessels are present.

The stigmata are straight and number from 4 to 6 in a mesh. Meshes are numerous. There are finger-shaped lobes at the branchial and atrial openings.

The dorsal tubercle is curved, with inturned horns.

The tentacles are very numerous, long and filamentous.

In this species the outline of the mantle shows conspicuously through the test. The stomach is longitudinally ribbed (fig. 11). The genitalia lie in regular rows round the outer curve of the intestine (fig. 11.)

Family Clavelinidæ Forbes, 1853.

Ecteinascidia turbinata Herdm. (Plate LXV. fig. 12.)

The description in the 'Challenger' account applies to the specimens of this species.

Measurements of specimens:—

	1.	2.	3.
Length	1·2 cm.	2·2 cm.	2·8 cm.
Breadth of anterior end ...	0·5 cm.	0·9 cm.	1·0 cm.

The branchial sac occupies most of the space within the test, is not folded, and possesses distinct longitudinal bars. Papillæ are not present on the longitudinal bars, but there are numerous lappets projecting inside the sac.

The tentacles are very numerous, simple and filiform, with very minute tubercles present on them. They are of two dimensions.

The stomach is small, and the intestine after leaving it runs for a short distance anteriorly, then slopes across the left side of the posterior part of the branchial sac from the ventral to the dorsal edge and is continued anteriorly as a dark-coloured rectum.

Sub-Order 2. **Ascidiæ Compositæ** Savigny, 1816.

Family Botryllidæ Giard, 1872.

Sarcobotrylloides wyvillii Herdm. (Plate LXV. figs. 13–15.)

Colony.—Six colonies came under observation. Each colony is onion- or balloon-shaped, slightly incrusting with, in some cases, a short tapering peduncle. The colonies had been attached to soft slimy-looking débris, which still adheres in places.

Sizes of colonies:—

	1.	2.	3.	4.	5.
Length ...	1·15 cm.	0·7 cm.	0·65 cm.	0·7 cm.	0·65 cm.
Breadth...	1·0 cm.	0·8 cm.	0·75 cm.	0·85 cm.	0·8 cm.

The ascidiozooids are aggregated on the upper hemisphere and appear black or very dark purple in the preserved specimens. In their natural state the colonies show "yellow lines on a dark brown ground." There is a fairly definite distribution of the zooids of each colony. Two or three rows of alternating paired zooids are diagonally inclined across the inner surface of the common test, while shorter rows of paired zooids fill up the intermediate space and complete the occupation of that part of the hemisphere.

Ascidiozooids (fig. 14).—The ascidiozooids are not much elongated antero-posteriorly and are slightly inclined to the surface of the test. An anal tentacle is present. Of two individuals measured the following dimensions were found:—

	1.	2.
Length	2·0020 mm.	1·8326 mm.
Breadth (abdominal).....	0·6468 mm.	0·8624 mm.
Breadth (thoracic)	0·8932 mm.	1·0318 mm.

There are also present numerous smaller individuals about half the dimensions of the larger ones.

The test is gelatinous, and swollen at that part where the colony is congregated. It is transparent or translucent in places, especially at the peduncular region and round the margin of the colony. Club-shaped vascular appendages with swollen end-bulbs (fig. 15) and filled with blood-corpuscles penetrate the matrix of the test and are very numerous.

The mantle is stout. Muscle-bands form an irregular network.

The branchial sac is well developed. Longitudinal bars are present internally and divide the inner surface into meshes. The stigmata are straight and there are six in a mesh; they are

quite regularly arranged, of elongated elliptical shape, and about as wide as the longitudinal vessels between them.

The tentacles are 16 in number, 8 large and 8 small.

The dorsal lamina is a plain narrow membrane.

The dorsal tubercle is a small circular aperture.

The alimentary canal is somewhat posterior to the branchial sac, thus making two imperfectly defined regions to the animal. The stomach is dilated and has from 4 to 5 longitudinal striations on each side.

Reproductive organs lie alongside the alimentary canal.

Three small colonies were found at 3 fathoms depth.

Herdman's specimens differ from the foregoing in minor particulars only; the colony examined by him is larger and also irregular in form, while the present examples are quite definite in shape. The ascidiozooids of the Cape Verde specimens appear to be in most cases larger than those of the type of the species. Lastly it is of interest to note that Herdman's examples from the North Atlantic occurred at 363 fathoms; the Cape Verde specimens were found in comparatively shallow water, viz. 3 fathoms.

SARCOBOTRYLLOIDES PARVUM, sp. n. (Plate LXV. figs. 16 & 17.)

The colony consists of a number of lobed fleshy masses united to a common trunk by short stalks (fig. 16). Ascidiozooids are present throughout the whole investing test. The size of a single lobe of the colony (fig. 17) is—length 12·5 mm., breadth 6 mm., and thickness 3 mm. The colour of the whole (spirit specimen) is pale purple, translucent between the ascidiozooids and around the margins. The ascidiozooids are brick-red in colour, are very minute and lie in elongated double rows; no common cloacal aperture was seen.

Dimensions of ascidiozooids;—

	1.	2.	3.
Length	1·078 mm.	1·232 mm.	0·770 mm.
Breadth.....	0·539 mm.	0·462 mm.	0·385 mm.

The test is firm; it is penetrated by many bulbous vessels which are of a reddish-purple colour like the zooids themselves. The vascular bulbs are readily seen, relatively large, ovate, rounded and spindle-shaped. Numerous corpuscles are present in the bulbs. The branchial sac is large; there are seven stigmata in a dorso-ventral row. The dorsal lamina is a plain membrane. The tentacles are about eight in number.

The branchial and atrial apertures are near each other and are almost terminal.

The alimentary canal lies alongside and at the posterior end of the branchial sac. The stomach has ten longitudinal folds. The gonads lie on each side of the branchial sac.

The material is badly preserved, and some points could not be made out with certainty, *e.g.*, the number of tentacles or the characters of the dorsal tubercle.

Family Distomidæ Giard, 1872.

Distoma capsulatum Van Name. (Plate LXV. fig. 21.)

The colony is incrusting, more or less lobed, light brown or greyish in colour, permeated with amorphous calcareous particles. Size 25 mm. by 14 mm. and about 5 mm. in thickness.

The test is semi-cartilaginous, no systems are apparent, and the zooids are relatively few in number.

The ascidiozooids (fig. 21) are elongated antero-posteriorly and divided into a short branchial and a long abdominal region. The branchial region measures 1·25 mm. and the abdominal is more than twice as long.

The mantle is highly muscular. The muscles are arranged in well-defined longitudinal and transverse bands on the surface of the pharynx.

The branchial sac is short, and the branchial aperture is 6-lobed. This aperture is apparently capable of being everted. The endostyle is large and undulating. In the young forms the separation between branchial and abdominal regions is not clearly marked.

The atrial aperture, placed a short distance behind the branchial, is also 6-lobed.

The tentacles are simple and fairly numerous.

Vascular processes arise from the posterior end of the abdomen. The hepatic glands surrounding the intestine consist of numerous tubules on the anterior portion of the intestine.

Only a small colony was found, and it is doubtfully placed in this species. The characters made out agree well with Van Name's description of the type, although some points remain unverified for lack of satisfactory material.

Previously recorded from Bermuda below extreme low-water mark.

Family Polystyelidæ Herdman, 1886.

Synstyela incrustans Herdm. (Plate LXV. fig. 22.)

Two colonies referred to this species came under observation. One of these spreads over *Styela corrugata*, covering about 6 sq. cms. of surface and varying in thickness from 1 to 2 mm. The other colony was attached to the tube of a Sabellid worm in an investing mass of about 3 sq. cms. Slight differences in external appearance occur in both these colonies. The mass which covered the simple ascidian was tough in texture and dirty white in colour. The zooids did not project above the common surface of the colony; they are oval, and in length measure 2·5 mm., in breadth 1·5 mm. A distinct bluish tinge is noticeable in those zooids which cover the tube of the Sabellid worm. Each zooid is slightly elevated, and there is a more distinct separation between each animal than in the first mentioned colony. The size of each individual is about 6–7 mm. in length and 2–3 mm. broad.

The test contains vascular bulbs, and rosette-shaped spicules are sparsely present.

The branchial and atrial openings are not closely apposed and are slit-like without lobes, both being present on the exposed surface of the zooid.

A well-developed branchial sac shows distinct longitudinal bars, straight stigmata, and a dorsal lamina with a plain membrane.

The alimentary canal lies alongside the branchial sac. The stomach is longitudinally ridged and has a cæcum.

The dorsal tubercle is oval.

The tentacles are simple.

In branchial stigmata, lamina, tentacles, tubercle, bars, &c., these two specimens agree with Herdman's description.

The apertures are distinctly slit-like and there is no suggestion of lobes.

Family Polyclinidæ Giard, 1872.

Amaroucium crosslandii, sp. n. (Plate LXV. figs. 18–20.)

The colony is fleshy and incrusting, and from its base of attachment it grows up in an irregular convex manner towards the top. The colour is a dirty yellow. The surface is smooth and glistening. The length is about 6·5 cm. and breadth 4·6 cm. and thickness ·5 cm.

The ascidiozooids are about 1·5 mm. long, are slender and club-like, terminating posteriorly in a bluntly rounded end (fig. 18). They lie at right angles to the surface of the test. Each is divided into three regions—branchial, abdominal, and postabdominal. The branchial aperture is terminal and 6-lobed; the atrial, which is situated dorsally, has a long languet. The zooids occupy cavities in the test, which have each a separate opening to the exterior. These openings occur in no definite arrangement. The zooids in some instances were found extruded through these apertures. The upper part of the test is soft and fleshy and surrounds the branchial and abdominal regions of the animal. The lower part is tough, and in it is embedded the postabdominal portion of the animal. The postabdomen is comparatively short.

The test as already noted is firm and cartilaginous in the lower part of the colony and soft and gelatinous in the upper part. It is semitransparent and contains very few vessels. Terminal bulbs are present.

The mantle musculature, which forms an irregular network, is well developed, particularly the longitudinal bands.

The branchial-sac stigmata, in young specimens, are small, oval, and fairly numerous (fig. 19), but longer slit-like stigmata are present in older individuals. Numerous papillæ project from the sac into the branchial chamber. Longitudinal bars are absent.

The endostyle is large and conspicuous and has a regularly undulating course (fig. 20).

The dorsal lamina is formed of a large number of closely

placed languets. Both languets and branchial papillæ resemble each other in size.

The tentacles are simple and few in number, probably 8.

The dorsal tubercle is an oval slit.

The alimentary canal is of an opaque, greyish-yellow colour. The stomach has 10–12 longitudinal folds. The rectum is long and wide.

Three small pieces were found. The most distinctive characters of this species appear to be the presence of distinct branchial papillæ, the number of stomach-folds, and the short post-abdomen.

Family Didemnidæ Giard, 1872.

Leptoclinum sp.

One small colony of *Leptoclinum* (Pl. LXV. fig. 23), growing on calcareous algæ, came under observation. The zooids were quite disintegrated, and no diagnosis beyond that of the colony was possible.

The colony in general appearance is white. An outer layer of a thin crust and a lower layer fairly thick, gelatinous and brownish, seemed to have at one time contained the zooids.

The systems are not well defined.

Common cloacal apertures are not apparent.

The branchial apertures are 6-lobed.

Stellate calcareous spicules are very numerous.

Literature referred to.

Herdman, W. A.—Report on the Tunicata collected during the Voyage of H.M.S. 'Challenger.'
Part I. Ascidiæ Simplices. 1882.
Part II. Ascidiæ Compositæ. 1886.

Herdman, W. A.—"A Revised Classification of the Tunicata." Journal of the Linnean Society, Zoology, 1891, vol. xxiii. p. 558.

Van Name, Willard G.—"The Ascidians of the Bermuda Islands." Trans. Connecticut Academy of Arts and Sciences, vol. xi. 1902.

EXPLANATION OF THE PLATES.

Plate LXIV.

Fig. 1. Part of branchial sac of *Halocynthia rubrilabia*. × 250. (p. 904.)
2. Tentacles of *H. rubrilabia*. × 250. (p. 904.)
3. Dorsal tubercle of *H. rubrilabia*. × 250. (p. 904.)
4. Right side; 5. Left side of *H. rubrilabia*, showing ovaries (*o*), testes (*t*), intestine (*i*), and renal organs (*r*). × 40. (p. 904.)
6. Dorsal lamina showing languets of *H. rubrilabia*. × 250. (p. 904.)
7. *Styela partita* Stimpson. × 2. (p. 904.)
8. *Halocynthia rubrilabia* Verrill. × 2. (p. 904.)
9. Dorsal tubercle of *Styela partita*. × 220. (p. 905.)
10. *Ascidia obliqua* Alder. × 1. (p. 905.)
11. Dissection of *Ascidia obliqua* showing coils of intestine, stomach, and gonads. × 1. *st*, stomach. (p. 905.)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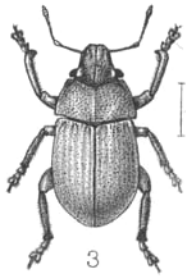
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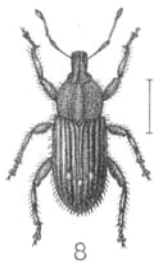
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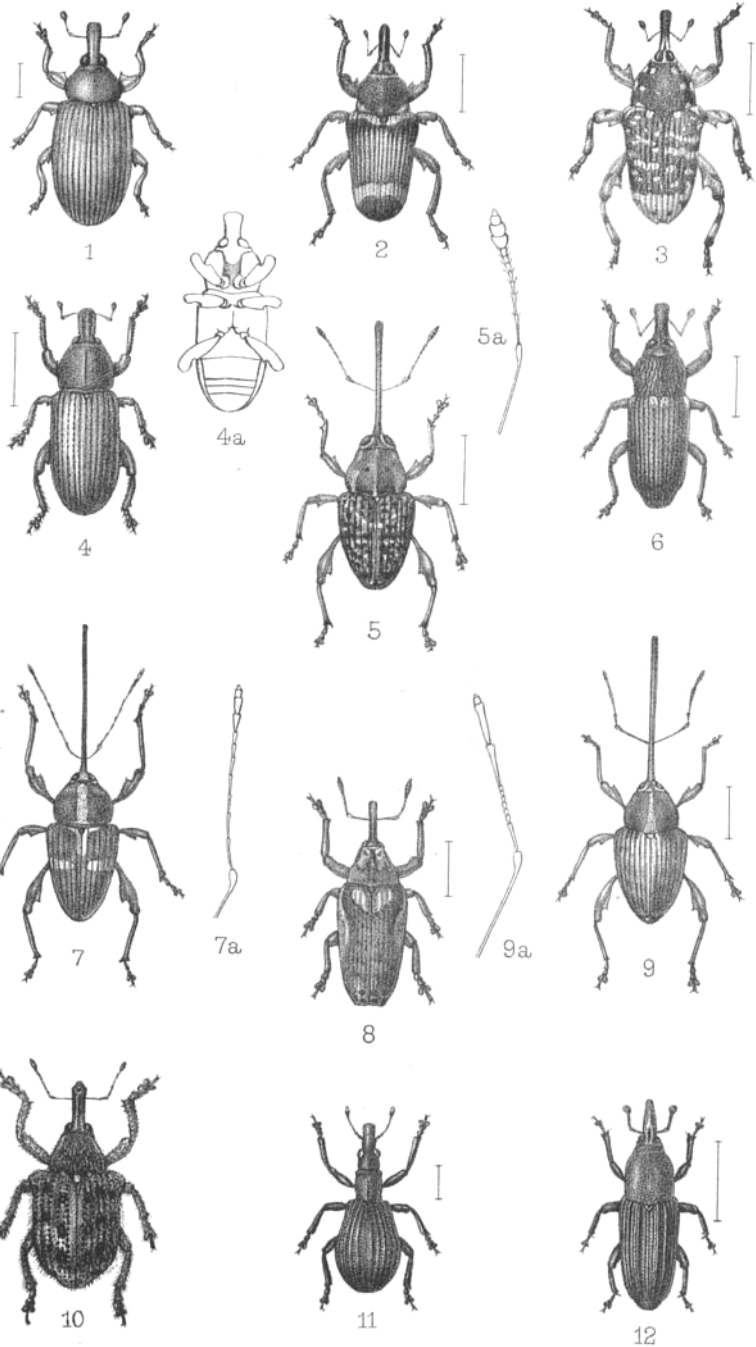
Horace Knight del. et lith. West, Newman imp.

NEW AFRICAN CURCULIONIDÆ.



Horace Knight del.et lith. West, Newman imp.

NEW AFRICAN CURCULIONIDÆ.

PLATE LXV.

Fig. 12. *Ecteinascidia turbinata*, showing stomach (*st*) and intestine (*i*). (p. 905.)
13. Colony of *Sarcobotrylloides wyvillii* Herdm. × 5. (p. 906.)
14. Zooid of do. × 48. *a.t*, anal tentacle. (p. 906.)
15. Vascular bulbs from test of do. × 220. (p. 906.)
16. Colony of *Sarcobotrylloides parvum*, sp. n. × 5. (p. 907.)
17. Lobe of colony of *S. parvum*. × 10. (p. 907.)
18. Zooid of *Amaroucium crosslandii*, sp. n. × 20. (p. 909.)
19. Stigmata of *Amaroucium crosslandii*. × 48. (p. 909.)
20. Endostyle of *Amaroucium crosslandii*. × 48. (p. 909.)
21. Zooid of *Distoma capsulatum* Van Name. × 48. (p. 908.)
22. Colony of *Synstyela incrustans* Herdm. × 1. (p. 908.)
23. Portion of surface of a *Leptoclinum* colony. × 48. (p. 910.)

2. On New Species of African Coleoptera of the Family Curculionidæ. By GUY A. K. MARSHALL, F.Z.S.

[Received October 5, 1906.]

(Plates LXVI. & LXVII.*)

The following is a list of the species dealt with in this paper:—

Ectatops sheppardi.
Strophosomus salisburiensis.
„ binotatus.
„ sulcatifrons.
„ acuticollis.
Platycopes alfredensis.
„ tuberculatus.
Piazomias varicolor.
„ deceptor.
„ pratensis.
Rhinosomphus mutabilis.
Catamonus tristis.
Systates dentipes.
Ellimenistes callosicollis.
Zeugorygma (g. n.) hirta.
„ orangiæ.
Hipporrhinus mendicus.
„ impressicollis.
„ monilis.
„ dispar.
„ foveolatus.
„ montanus.
„ purcelli.
Cyclomus algoensis.
„ simplex.
Myorrhinus longstaffi.
Rhyparosomus mashunus.
Diabathrarius setulosus.
„ velutinus.
Hypsomus parvus.
Bagous punctipennis.
„ beiranus.
„ humeralis.
„ senegalensis.
„ promontorii.
Phacemastix trinotata.
„ pardalis.
„ poultoni.
Aplemonus zizyphi.
Euops cyaneus.
Balaninus nubifer.
„ ficorum.
„ aurivillii.
„ barkeri.
„ diversicornis.
Euderes natalis.
Euderoides (g. n.) mossambica.
Neiphagus mashunus.
Pachyonyx niveus.
„ triangularis.
Endeus floralis.
„ bauhiniæ.
„ hispidus.
Acanthorrhinus carinatus.
„ zambesianus.
And
Cyrtorrhinus castaneipennis *Boh.*

ECTATOPS SHEPPARDI, sp. nov. (Plate LXVI. fig. 1.)

Long. $5\frac{1}{5}$–9, lat. $2\frac{2}{5}$–$4\frac{2}{5}$ mm. †

Colour black, densely and uniformly covered with pale grey scaling which usually has a decided pinkish reflection; scales on the tarsi often with a pale green reflection.

* For explanation of the Plates, see p. 958.
† All length measurements are exclusive of the rostrum.

Head strongly transverse; forehead with a deep central furrow, but without any supra-ocular tubercle; eyes very prominent and subconical in shape. *Rostrum* separated from head by a deep transverse furrow, as long as broad, the sides straight and slightly narrowed from base to apex; upper surface plane, with five short and rather shallow longitudinal impressions in the basal half which are more or less hidden by the dense scaling. *Antennæ* densely squamose, the scape reaching the posterior margin of eye, the two basal joints of the funicle subequal. *Prothorax* much broader than long, basal margin faintly bisinuate, apical margin narrower and truncate, sides moderately rounded and broadest about middle; upper surface convex, rugosely punctured throughout and with a very short longitudinal impressed line in the middle of the base. *Elytra* subovate, with a shallow basal constriction, the basal margin jointly emarginate, subacuminate at apex; sides rounded, broadest not far from base owing to the presence of a low rounded prominence on the inflexed margin below the shoulders; upper surface convex, steeply declivous behind, with deep punctures forming three regular rows near the suture, but irregular laterally especially in the basal half, the intervals smooth and impunctate. *Legs* stout, densely squamose; tibiæ sparsely pilose, not crenulate internally, but with from three to six stout spine-like setæ on the apical half; tarsal claws connate at base.

Port. E. Africa: Beira (*P. A. Sheppard*).

Types, ♂ in the British Museum, ♀ in the Oxford Museum.

Much smaller than *E. cinerosus* Fåhr., which differs in having a prominent supra-ocular tubercle and a much more elongate prothorax with a deep central furrow; the eyes are not conical, the punctuation of the elytra is in regular rows throughout, and the tibiæ are distinctly crenulate and densely pilose.

Through the kindness of Mr. Sheppard I have been able to examine a good series of this species, which varies considerably in size.

Strophosomus salisburiensis, sp. nov.

Long. 5–6$\frac{4}{5}$, lat. 2$\frac{3}{5}$–4 mm.

Colouring extremely variable, being either uniform grey, or grey mottled or striped with brown, or light brown mottled with dark brown and grey; thorax always with two paler stripes, and two pale spots adjoining them at the base of the elytra.

Head almost plane, closely punctured and with a broad and deep central furrow; eyes rather prominent, rounded, the posterior margin of the orbit produced into a short sharp point. *Rostrum* separated from head by a deep subarcuate furrow which does not reach the margin, gradually narrowed from base to apex, the sides straight; upper surface plane, with two broad deep oblique sulci which join the basal furrow at a little distance from each other. *Antennæ* rufescent with the club fuscous; second joint of the funicle distinctly longer than the first. *Prothorax* moderately transverse, base and apex of equal width and both truncate, sides

slightly rounded, broadest at middle; upper surface convex, with a shallow transverse impression before middle, somewhat closely set with small low granules and with a faint narrow central carina. *Elytra* subglobose, truncate at base, basal angle not prominent, sides strongly rounded, broadest rather before middle; upper surface very convex, with shallow striæ containing rows of deep separated punctures, the intervals broad, almost plane, smooth and devoid of true setæ. *Legs* moderate, similar in the two sexes, the anterior tibiæ shallowly sinuate internally.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

This species is the local representative of *S. lineatus* Fåhr., which occurs commonly in Matabeleland and which may be distinguished from it by the following characters:—Its more prominent eyes; the entire absence of the orbital projection behind the eye; the prothorax is distinctly narrowed towards the base, being broadest close to the apex; and finally the oblique rostral furrows unite at the base.

STROPHOSOMUS BINOTATUS (Fst. *in litt.*), sp. nov.

Long. 8–8½, lat. 4¼–4½ mm.

Colour black, with opalescent grey scaling which is paler and denser laterally; the elytra sometimes with a more conspicuous paler spot behind middle.

Head closely punctured and with a deep central furrow; eyes prominent, rounded, but not directed backwards, the posterior margin of the orbit produced into a sharp point. *Rostrum* separated from head by a transverse furrow which does not reach the margin, and strongly narrowed from base to apex, its sides straight; upper surface plane, closely punctured, with a smoother central line and a shallow oblique basal sulcus on each side of it. *Antennæ* black, with pale pubescence; the second joint of funicle distinctly longer than the first. *Prothorax* strongly transverse, subcylindrical, base and apex of equal width, sides scarcely rounded, basal margin arcuate, apical margin broadly sinuate; upper surface convex, with a transverse impressed line close to apex and without any central carina, closely punctured and with scattered small granules showing through the scaling, which is usually denuded in the middle. *Elytra* ovate, subtruncate at base, shoulders very oblique, sides rounded, broadest about middle, apex broadly rounded; upper surface convex, with distinct deeply punctured striæ, the intervals convex, smooth and devoid of setæ. *Legs* black, with dense grey scaling and short pale setæ.

MASHONALAND: Salisbury (*G. A. K. M.*). PORTUGUESE E. AFRICA: Amatonga's (*P. A. Sheppard*). GERMAN E. AFRICA.

TYPE in the British Museum.

The narrowness of the shoulders gives this insect a somewhat characteristic pear-shaped facies. It is allied to *S. lineatus* Fåhr. and *S. salisburiensis* Mshl., both of which differ from it in having

the rostrum less narrowed in front, in their less transverse prothorax, which is truncate at base and apex, and in their more rotund elytra.

STROPHOSOMUS SULCATIFRONS, sp. nov. (Plate LXVI. fig. 2.)

Long. $7\frac{2}{5}$–9, lat. $4\frac{1}{5}$–$5\frac{1}{5}$ mm.

Colour black, with dense grey or brownish scaling, prothorax with a darker subdenuded central stripe, each elytron usually with two very faint paler spots placed obliquely about middle.

Head broad, plane, with seven broad and deep sulci, separated by narrow carinæ and becoming shorter outwardly; eyes very prominent, projecting backwards and subacuminate posteriorly. *Rostrum* separated from head by a narrow curved stria which is obsolete laterally, strongly narrowed anteriorly, its sides sinuate near apex; upper surface with four deep sulci which are much broader than those on head. *Antennæ* fuscous, joints 1 and 2 of funicle subequal. *Prothorax* more than twice as broad as long, apex sinuate, a little narrower than the base which is broadly curved, sides dilated into a sharp angular projection slightly behind middle; upper surface convex, coarsely and longitudinally rugose, with a complete smooth narrow central carina. *Elytra* broadly ovate, jointly sinuate at the base, with the basal angles projecting a little beyond the base of the prothorax and subacute; sides rounded, broadest rather behind middle; upper surface convex, with broad sulci containing rows of deep punctures; the intervals convex, smooth, finely aciculate and each with two irregular rows of very short subrecumbent setæ. *Legs* moderately stout; anterior tibiæ straight, but with the internal apical angle sharply produced.

ORANGE RIVER COLONY: Bothaville (*Dr. H. Brauns*). NATAL: Charlestown (*A. E. Haviland*). TRANSVAAL: Johannesburg (*H. Fry*).

TYPE in the British Museum.

In the twelve examples before me I cannot detect with certainty any external sexual differences.

Of the described S. African *Strophosomi* only *S. strigifrons* Fåhr. and *S. plumbeus* Fåhr. (which are doubtfully separable) exhibit a series of sulci on the forehead. But in these insects the sulci are more numerous and much shallower; in them also the prothorax is not angulated laterally, the elytra are much more elongate, and the striæ are finer and less coarsely punctured.

STROPHOSOMUS ACUTICOLLIS, sp. nov. (Plate LXVI. fig. 3.)

Long. $4\frac{3}{5}$–$6\frac{2}{5}$, lat. $2\frac{2}{5}$–$3\frac{1}{5}$ mm.

Colour black, covered with dense uniform grey scaling and devoid of true setæ.

Head plane, closely punctured and with a deep narrow central furrow; eyes very prominent, directed backwards and acuminate posteriorly. *Rostrum* separated from the head by a narrow

angulated furrow which is continued to the margin, comparatively elongate, strongly narrowed from base to apex, with its sides almost straight; upper surface plane, depressed in the centre and with three faint carinæ which are often more or less obsolete. *Antennæ* dark rufescent, with the club fuscous; the two basal joints of the funicle subequal. *Prothorax* strongly transverse, twice as broad as long, sides almost straight, broadest at base; apex deeply emarginate, much narrower than the base which is rounded in the middle and deeply sinuate on each side close to the exterior angles, these angles are very sharp and project well beyond the base of the elytra; upper surface gently convex, with fine confluent punctuation throughout which is hidden by the dense scaling, and with no trace of any central carina. *Elytra* oblongo-ovate, jointly and deeply emarginate at base, the basal angles sharp, prominent and subrectangular, the sides straight from the basal angle to about middle, thence roundly narrowed to apex; upper surface moderately convex in ♀, subdepressed and less steeply declivous posteriorly in ♂, in which sex also the lateral margins are more sharply inflexed, striæ with rows of shallow punctures; the intervals smooth and impunctate, almost plane in ♂, slightly convex in ♀. *Legs* thick, similar in the two sexes; anterior tibiæ straight, denticulate internally and with the apical angle very strongly produced inwardly.

ORANGE COLONY: Bothaville (*Dr. Hans Brauns*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Nearly allied to the aberrant *S. brevicollis* Fåhr., with which it quite agrees in general facies. That species however is covered with distinct erect setæ, the prothorax has a short central carina, and the legs are a good deal more slender.

PLATYCOPES ALFREDENSIS, sp. nov.

Long. $4\frac{3}{5}$–$5\frac{3}{5}$, lat. 3–$3\frac{4}{5}$ mm.

Dark piceous brown, with uniformly dense grey or ochreous-grey scaling, the elytra sometimes variegated with brown markings.

Head convex on vertex, flattened on forehead, finely and longitudinally aciculate, without any superciliary prominence. *Rostrum* separated from head by an angulate impression, the lateral carinæ less evident towards the base. *Antennæ* with the scape strongly dilated, its posterior margin sharply angulate not far from apex, funicle with joint 2 much longer than 1, and 7 longer than 6. *Prothorax* twice as broad as long, its base fitting closely to the elytra in both sexes; sides rounded, broadest near base, strongly constricted near apex, and with a transverse impressed line; upper surface convex, closely granulate except along the anterior margin. *Elytra* suborbicular, jointly sinuate at base in both sexes, moderately convex, the antero-posterior curvature comparatively low, slightly greater in the ♀, basal angle sharp, the sides obliquely ampliated from there to the

subhumeral tubercle and rounded posteriorly; upper surface with shallow striæ containing large punctures which are partially hidden by the scaling, the intervals plane, smooth and impunctate. *Legs* normal, rather stout; anterior tibiæ a little thicker and more curved internally in the ♂ than in the ♀.

CAPE COLONY: Port Alfred (*Father O'Neil*).

TYPES, ♂ ♀ in the British Museum.

The sexual differences are slight, being confined to the anterior tibiæ and the slightly greater convexity of the elytra in the ♀; there appears to be no difference in the development of the humeral tubercle.

PLATYCOPES TUBERCULATUS, sp. nov.

Long. $5\frac{1}{5}$, lat. $3\frac{3}{5}$ mm.

Colour black, with earth-brown scaling.

Head very short, nearly three times as broad as long, flattened and longitudinally rugose. *Rostrum* separated from head by a straight transverse impression, subquadrate, but rather narrower apically, the lateral carinæ obtuse but continued to base. *Antennæ* with the scape strongly dilated, its anterior margin only slightly curved, its posterior margin simply rounded; the funicle with joints 1 and 2, and also 6 and 7, subequal. *Prothorax* transverse, its length greater than half its breadth, broadest close to base, much narrower (but scarcely constricted) at apex, sides slightly rounded; upper surface convex, uneven, rugose and with a few indistinct tubercles. *Elytra* as broad as the prothorax and jointly sinuate at base, sub-orbicular, the sides obliquely ampliated from base to the sub-humeral tubercle, which is prominent; upper surface convex, with a single regular juxta-sutural row of punctures, the remainder of the surface with large irregular punctures; each elytron with three rows of large rounded tubercles, the rows containing 5 (or 6), 4 and 4 tubercles respectively from the suture outwards, and in addition a small common tubercle on the suture not far from the base. *Legs* comparatively slender, the tibiæ sub-linear but all produced inwardly at the apex.

TRANSVAAL (*T. Ayres*).

TYPE in the British Museum.

In the British Museum (Fry Collection) there is a series of eight specimens of this very distinct species, and I have received a single example from my friend Dr. W. Horn.

Schönherr was clearly unacquainted with the marked sexual differences which occur in the genus *Platycopes*, for most of the distinctive characters which Boheman specially emphasises have merely a sexual significance.

The following synopsis of the known species may therefore facilitate identification:—

1. (20.) | Elytra not tuberculate, but with regular punctured striæ.
2. (15.) | Body with grey or brown scaling.
3. (4.) | Head with a prominent supra-ocular tubercle. *P. gravidus* Pasc.
4. (3.) | Head without any supra-ocular tubercle.
5. (6.) | Prothorax more raised dorsally in front ..... *P. spathulatus* Gyl.

6. (5.)	Prothorax not elevated anteriorly.
7. (10.)	Posterior margin of scape sharply angulate.
8. (9.)	Prothorax not constricted or impressed near apex; first joint of funicle equal to, or slightly longer than, second. *P. squalidus* Boh.
9. (8.)	Prothorax evidently constricted and with a transverse impressed line near apex; second joint of funicle longer than first ..... *P. alfredensis*, sp. nov.
10. (7.)	Posterior margin of scape simply rounded.
11. (12.)	Second joint of funicle evidently longer than first. *P. gonopterus* Boh.
12. (11.)	First joint of funicle as long as, or longer than, second.
13. (14.)	Rostrum not elevated dorsally; first joint of funicle equal to the second ..... *P. turgidus* Boh.
14. (13.)	Rostrum subelevated dorsally; first joint of funicle longer than second..... *P. pygmæus* Boh.
15. (2.)	Body with green scaling.
16. (17.)	Rostrum separated from head by an angulated stria. *P. argyrellus* Sparrm.
17. (16.)	Rostrum separated from head by a straight transverse stria.
18. (19.)	Elytra with an infra-humeral tubercle ..... *P. virens* Boh.
19. (18.)	Elytra with no infra-humeral tubercle ..... *P. prasinatus* Boh.
20. (1.)	Elytra each with three rows of large tubercles, the interspaces with large irregular punctures ..... *P. tuberculatus*, sp. nov.

I have received from Father O'Neil a pair of *P. gonopterus* Boh., taken *in coitu* on *Euphorbia*. Boheman has described the ♂ only. The ♀ differs in having the basal margin of the elytra truncate and narrower than the prothorax, whereas in the ♂ the base is jointly sinuate and as broad as the prothorax, which it embraces. Owing to this the sides of the prothorax appear to be much more strongly rounded in the ♀. The latter sex also has the infra-humeral tubercle of the elytra very much more prominent; the elytra are more convex, and the legs are thinner, the posterior pairs of tibiæ not being dilated as in the ♂.

From the same indefatigable collector I have received also a pair taken *in coitu* of a species which I attribute to *P. pygmæus* Boh., the type of which is lost. In this case the only structural differences consist in the much more convex or globose elytra and the slightly more prominent humeral tubercle of the ♀; the leg structure is practically identical, those of the ♂ being, if anything, the thinner. But whereas the ♂ is of a uniform grey colour, the ♀ is brown with the alternate intervals whitish, the stripes being more or less broken up.

The type of *P. prasinatus* Boh. is missing, but from the description this species seems to differ from *P. virens* Boh. only in the absence of the humeral tubercle. It is therefore highly probable that the former will prove to be merely the ♂ of the latter.

I examined the type of *P. alternans* Boh. at Stockholm, and certainly cannot separate it from *P. gonopterus* Boh., of which it is no more than a slight variation.

The genus *Piotypus* was founded by Pascoe (Cist. Ent. ii. 1881, p. 596) for the reception of his *P. gravidus*; but there is no character by which this species can be separated from *Platycopes*, with which it is here included.

PIAZOMIAS VARICOLOR, sp. nov.

Long. 6–7, lat. $2\frac{3}{5}$–3 mm.

Head slightly convex, rugosely plicate and with a narrow central stria, the sculpturing more or less hidden by dense scaling; eyes lateral, almost circular. *Rostrum* about as long as head, subquadrate and not narrowed apically; upper surface plane, subrugose, plicate in the basal half, usually with a shallow depression in the middle and with a central stria continuous with that on the head, with dense scaling and short erect pale setæ. *Antennæ* piceous, with grey pubescence; scape abruptly clavate, reaching middle of eyes; funicle with first joint much longer and thicker than the rest, second as broad as third and only a little longer. *Prothorax* as long as broad, truncate at base, apical margin scarcely narrowed and slightly rounded dorsally, sides moderately rounded, broadest at middle; upper surface convex, but subdepressed in the middle, closely set with round flattened tubercles except along the median part of the anterior margin, and with a distinct narrow central furrow which reaches neither base nor apex; colour black, with dense scaling which is fuscous dorsally with two paler bands of either grey, light brown or dull gold; the underparts entirely of the same colour as the discal bands. *Elytra* ovate, the basal margin a little broader than the prothorax, truncate and narrowly elevated; sides slightly rounded, broadest about middle; upper surface somewhat convex and gradually declivous behind, with distinct deeply punctured striæ; the intervals narrow, convex, finely aciculate and with regular rows of long erect distant pale setæ; colour black, covered with dense scaling of very variable colouring, being either uniform pale sandy grey, dark grey or dull golden, or grey with darker mottling, or dark brown with a broad lateral stripe of brownish pink. *Legs* with dense grey scaling and pale setæ; tibiæ strongly crenulate internally, especially the anterior pair.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

The long erect setæ on the elytra will render this species easily recognisable.

PIAZOMIAS DECEPTOR, sp. nov.

Long. $5\frac{4}{5}$–6, lat. $2\frac{2}{5}$–$2\frac{1}{2}$ mm.

Head broad, slightly convex, coriaceous, not plicate, and with a narrow central stria. *Rostrum* as long as head, subquadrate, scarcely narrowed apically; upper surface plane, coriaceous, with a very short central furrow in the basal half and close to it on each side a much longer furrow which curves strongly backwards towards the inner margin of the eye; the sculpturing normally hidden by dense scaling. *Antennæ* quite similar to those of *P. varicolor*. *Prothorax* as long as broad, basal margin faintly sinuate, apical margin a little narrower and slightly lobate; sides moderately rounded, broadest at middle; upper surface somewhat convex, rugosely coriaceous, but smoother near apical margin and

with a fine abbreviated central stria: colour black, covered with dense grey or pinkish scaling and with very short subdepressed white setæ. *Elytra* ovate, jointly sinuate at base and slightly broader than the prothorax, but the margin not raised, sides slightly rounded, broadest about middle; upper surface convex, gradually declivous behind, with regular and distinctly punctured striæ; the intervals slightly convex, smooth, finely aciculate and with regular rows of short depressed white setæ; colour black, with dense even scaling, which is either pale grey mottled with pinkish brown, or greenish grey above turning to pink laterally. *Legs* with dense grey scaling and pale setæ; the two anterior pairs of tibiæ crenulate internally, posterior pair smooth.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE ♀ in the British Museum.

Very similar in general facies to the preceding species, but differing in important details, such as, the absence of the long erect setæ, the presence of the curved sulci on the rostrum, the non-plicate forehead, and the less deeply punctured and non-marginate elytra. *P. palliatus* Fåhr. is a more slender insect, with the anterior legs, and especially the tarsi, much longer; the elytra are truncate at the base and the rostrum has a short carina on each side of the central furrow.

PIAZOMIAS PRATENSIS, sp. nov.

Long. $2\frac{4}{5}$–$3\frac{3}{5}$, lat. $1\frac{1}{5}$–$1\frac{3}{5}$ mm.

Head broad, convex, coriaceous, and with a fine central stria, with dense scaling, which is dark brown above scattered with pale squamiform setæ, and grey beneath and round the eyes. *Rostrum* as long as head and gradually narrowed from base to apex; upper surface with a central depression containing a distinct fovea which is usually connected with the cephalic stria; scaling as on head. *Antennæ* piceous, similar to those of *P. varicolor*. *Prothorax* as long as broad, base truncate, apex scarcely narrower and slightly lobate, sides rounded, broadest at middle; upper surface convex, with a distinct transverse impressed line just behind apex and a very fine central stria, which is often absent; colour black, with dense dark brown scaling and a sub-lateral and infra-lateral paler stripe on each side, also some scattered pale squamiform setæ. *Elytra* subovate, the basal margin scarcely broader than the prothorax, truncate and not elevated, sides moderately rounded, broadest rather behind middle; upper surface convex, steeply declivous behind, with distinctly punctured striæ, the intervals slightly convex, smooth, aciculate, and with rows of very short suberect pale setæ; colour black, with dense dark brown scaling which is somewhat paler laterally. *Legs* with dense scaling and pale setæ; tibiæ crenulate internally, except the posterior pair.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Apart from its much smaller size, this insect differs from both

varicolor and *deceptor* in the shape of its elytra, which are more bluntly rounded apically and much steeper on the declivity. It is more nearly allied to the latter, but lacks the curved furrows on the rostrum.

RHINOSOMPHUS MUTABILIS, sp. nov. (Plate LXVI. fig. 4.)

Long. $8\frac{1}{2}$–11, lat. $3\frac{1}{2}$–$4\frac{3}{4}$ mm.

Head almost plane above, with a deep central furrow, densely clothed with pale brownish or whitish scales and with a few scattered erect setæ; strongly constricted behind the eyes, which are subpedunculate, prominent and very convex. *Rostrum* separated from head by an angulated impressed line, about twice as long as head, but shorter than the prothorax, narrower than the forehead between the eyes, its sides slightly dilated apically; upper surface almost plane, with a very shallow central impression, the scaling dense and similar to that on head. *Antennæ* densely squamose and with scattered suberect setæ. *Prothorax* transverse, apex narrower than base, sides subparallel from base to middle, thence rapidly converging towards apex; basal margin strongly bisinuate, apical margin gently lobate dorsally; upper surface convex, with five deep longitudinal furrows, the central one straight and the costa on each side of it broad and rounded, the two lateral furrows rather sinuate and the costa between them narrower and subcarinate: the costæ with very dense pale scaling and with scattered dark setigerous punctures, the furrows dark brown. *Elytra* much broader than prothorax at base, shoulders very prominent and subrectangular; sides subparallel to middle, then rapidly narrowing to apex, the posterior declivity very steep and subcompressed; scutellum distinct, with dense pale scaling; upper surface convex, with distinct striæ containing rows of large deep punctures which are more or less hidden by the scaling, the intervals slightly convex, coriaceous, and with rows of closely-set erect dark setæ; scaling dense; colour variable: in the type form the ground-colour is light brown with an irregular angulated common dark marking before the middle and another behind the middle, the two enclosing a broad **V**-shaped patch of the ground-colour; these two markings are liable to become more or less obsolete; the ground-colour too varies to hoary white, and in some cases the intervals are alternately hoary white and dark brown, the dark discal markings being rather indistinct; the elytra are occasionally entirely abraded, appearing then of a shiny black colour. *Legs* with dense uniform pale brownish or white scaling and scattered setæ.

MASHONALAND: Salisbury, Umfuli R. and Rusapi (*G. A. K. M.*), Umtali (*A. Bodong*); MATABELELAND: Sebakwe (*D. Dodds*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

The genus *Rhinosomphus* Fairm. (Ann. Soc. Ent. Belg. 1896, p. 463) contains only one other species (*Stigmatotrachelus*) *guttiferus* Waterh. from Madagascar, which is a very different

looking insect, being of a rich crimson-brown colour with large patches of pure white.

CATAMONUS TRISTIS, sp. nov.

Long., ♂ $7\frac{1}{2}$–$8\frac{1}{2}$, ♀ $10\frac{1}{2}$; lat., ♂ 3–$3\frac{1}{2}$, ♀ $4\frac{1}{2}$ mm.

Head almost plane above, transversely wrinkled on vertex; forehead rugosely punctured and with three distinct furrows, normally hidden by dense brown scaling. *Rostrum* longer than head but scarcely as long as prothorax, stout, slightly curved and broadly dilated at apex; upper surface almost plane, closely punctured and scaled, with three fine carinæ of equal height; scrobes very deep anteriorly, broad and shallow behind, extending to anterior margin of eye. *Antennæ* piceous, with fine pale scaling and short depressed setæ; scape just exceeding posterior margin of eye; second joint of funicle longer than first. *Prothorax* transverse, apex much narrower than base, sides subparallel from base to about middle, then rapidly converging anteriorly; basal margin deeply bisinuate, anterior margin truncate; upper surface rather convex, closely and rugosely punctured, with a faint central furrow near base only; colour black or dark ferruginous, with greyish scaling more or less denuded. *Elytra* broadest at shoulders and gradually narrowed to apex, shoulders prominent, the base strongly trisinuate; upper surface with regular striæ containing rows of large deep punctures, which are normally hidden by the scaling, the intervals narrow, convex, and coriaceous, appearing much broader when the scaling is not denuded; colour dark ferruginous to black, with coarse brownish or greyish scaling (much denuded in the four examples examined) and very short subdepressed setæ. *Legs* black or piceous, rugosely punctured, and with pale scaling and setæ, which conceal the sulcus on the inner edge of the posterior pairs of tibiæ.

MASHONALAND: Mtoko's (*E. Head*), Mazoë (*J. ff. Darling*). MATABELELAND: Sebakwe (*D. Dodds*).

TYPE in the British Museum.

A near ally of the only other South African species, *C. melancholicus* Boh. (Natal and Transvaal), from which it differs in its much more transverse thorax, which has also a much fainter central furrow; the elytra are noticeably more slender in both sexes and the shoulders more prominent; the anal abdominal segment in the ♀ is much less acute.

SYSTATES DENTIPES, sp. nov. (Plate LXVI. fig. 5.)

♂ long. $5\frac{2}{5}$–$7\frac{1}{5}$, lat. $1\frac{4}{5}$–$2\frac{3}{5}$; ♀ long. $5\frac{3}{5}$–$6\frac{2}{5}$, lat. $2\frac{3}{5}$-3.

Colour bronze-black, with an ill-defined lateral stripe of thin pale scales on thorax and elytra; upper surface normally bare and shiny, but in a few females it is thinly covered with pale scales; no trace of setæ.

Head convex, shining, with scattered shallow punctures, which are closer and more confluent on the forehead where there is a

small elongate fovea. *Rostrum* longer than head, slightly longer than broad, its sides quite straight and parallel to apex, the pterygia not dilated; upper surface almost plane, rugosely punctured, with a narrow central carina and the margins sharply carinate. *Antennæ* very slender, ferruginous, with the club and apices of all the joints infuscate; scape very slender, cylindrical and abruptly clavate. *Prothorax* transverse (more so in ♀), broadest behind middle; sides strongly rounded in ♂, only slightly so in ♀, apex narrower than base; upper surface convex, bare, shining and without punctures or granules, sometimes with faint transverse aciculation or with traces of a central stria, lateral margin aciculate and with a stripe of pale scales. *Elytra* broadly ovate in ♀, much narrower and more elongate in ♂, truncate at base; shoulders extremely oblique; upper surface convex, with closely punctured striæ, the intervals broad, convex, smooth and very finely aciculate; entirely devoid of setæ. *Legs* piceous black, with sparse pale scaling and setæ; simple in ♀, except for a shallow excavation near apex of anterior tibiæ; in ♂ the anterior tibiæ are thickened laterally and with a stout perpendicular tooth about middle of the inner margin, while on the underside there is a large curved tooth, the outer apical half of the tibia being deeply excavated; the intermediate tibiæ have a long, slender, curved tooth before middle, while the posterior tibiæ are strongly but simply curved, with their inner surface flattened.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

An isolated species, somewhat resembling *S. amplicollis* Gerst. in general facies, but the structure of the legs is very different and the elytra are not constricted at the base as in that species; further, *dentipes* differs from this and all other described *Systates* known to me in the complete absence of granules on the prothorax.

It is a common insect about Salisbury throughout the summer, feeding on various grasses.

ELLIMENISTES CALLOSICOLLIS, sp. nov.

Long. $8\frac{4}{5}$, lat. $3\frac{1}{5}$ mm.

Colour black, with the entire body and limbs densely covered with brownish-grey scaling.

Head broadly but shallowly depressed on forehead; eyes short ovate, scarcely prominent. *Rostrum* scarcely longer than head, almost as broad as long, elevated and compressed between the antennæ and with a distinct central furrow which is broader and shallower towards base. *Antennæ* rather slender and elongate, squamose, and with scattered short white setæ; funicular joints of normal length. *Prothorax* transverse, broadest at base and regularly narrowed to apex, the sides being slightly rounded; basal margin strongly bisinuate and with the basal angles acute, anterior margin slightly concave; the upper surface is abruptly

elevated in the basal two-thirds, which is separated from the anterior part by a deeply bisinuate impressed line, the elevation is much highest in the centre, where it forms a very prominent callosity bearing a short deep central furrow; among the scaling are some scattered short squamiform setæ, which also form a sparse fringe along the basal margin. *Elytra* broad, subquadrate, deeply and jointly bisinuate at base; sides obliquely dilated to some distance from base, forming a prominent humeral angle, and from there gradually narrowed to the apex; upper surface convex, with fine striæ containing rows of large punctures (only visible when the scaling is removed); the intervals broad, slightly convex, shiny and finely aciculate; intervals 3 and 5* are elevated at the base, and the latter bears also a tubercular prominence which projects horizontally from the declivity and is much larger in the ♂ than in the ♀; each interval has an irregular row of very short depressed squamiform setæ. *Legs* normal, set with short, pale, suberect setæ.

CAPE COLONY: East London (*Dr. G. B. Longstaff*, Sept. 1905).

TYPE in the Oxford Museum.

This species is somewhat intermediate between *E. pulvinaticollis* Boh. and *E. bidentatus* Boh. In the former the structure of the thorax is very similar, but the insect is much larger, the elytra are more elongate and show no traces of the basal or posterior callosities. In size and facies *callosicollis* much resembles *bidentatus*, but in the latter species the thorax is simple and the elytra have no basal callosities.

ZEUGORYGMA, gen. nov. (Tanyrrhynchides.)

Head hemispherical; the eyes widely separated, convex. *Rostrum* rather longer than the head and prothorax, strongly curved; under surface as densely squamose as the upper; scrobes foveiform, placed very close together on the upper surface in front of the middle and with a very fine stria connecting them with the apex. *Antennæ* with the scape reaching nearly to the middle of the prothorax; the two basal joints of the funicle very elongate, the second slightly longer than the first. *Prothorax* transverse, broadest at base and rapidly narrowed to apex; basal margin arcuate; apical margin subtruncate dorsally, slightly lobate laterally and without vibrissæ; the anterior coxæ placed about in the middle of the prosternum. *Elytra* ovate, with oblique shoulders and with 10 finely-punctured striæ; the intervals smooth, almost plane, and with rows of very long erect hairs. *Legs* stout; femora unarmed, posterior pair not reaching the apex of the elytra; tibiæ straight, anterior pair not denticulate, corbels of posterior pair enclosed; tarsi short and broad, the second joint shorter and narrower than the first and third, fourth joint short, the claws small and connate. *Abdomen* with the

* The space between the suture and the first stria is reckoned as the first interval.

intercoxal process broad and truncate, segment 2 as long as 3 and 4 together and separated from 1 by a perfectly straight incision.

TYPE, *Z. hirta*, sp. nov.

This genus is evidently very closely allied to *Goniorhinus* Fst. (Deut. ent. Zeit. 1889, p. 143), from the Transvaal, with which I am not acquainted. Dr. K. M. Heller has, however, very kindly compared my specimens with Faust's type and considers them to be generically distinct, on the grounds that in *Goniorhinus* the eyes are approximated and the apical margin of the prothorax is vertically truncate. A further difference is to be found in the corbels of the posterior tibiæ, which are stated by Faust to be open and truncate. The species of this genus exhibit a close affinity to *Sympiezorrhynchus*, with which at first I provisionally associated them; they may, however, be discriminated superficially by their long erect setæ and the longer and more slender rostrum.

ZEUGORYGMA HIRTA, sp. nov.

Long. $3\frac{1}{5}$–$3\frac{3}{5}$, lat. $1\frac{4}{5}$–2 mm.

Colour black, with dull green scaling, the suture dull pink; the lateral margins and underparts pale with a metallic pink or golden reflection; body set with very long erect setæ.

Head subglobose, with dense scaling and a tuft of erect setæ above the eye, forehead with a central fovea. *Rostrum* elongate, a little longer than the head and prothorax, subcylindrical and distinctly curved; scrobes in the form of two deep oval fossæ on the upper surface, separated by a narrow carina, evanescent posteriorly, but continued to apex in the form of an extremely fine line; scaling rather sparse laterally but dense above, with short erect setæ on the basal half, which give the base an elevated appearance. *Antennæ* piceous, with pale scaling; funicle with joints 3 and 4 subequal in length. *Prothorax* transverse, broadest at base, which is gently curved, apex much narrower and constricted, the margin slightly lobate dorsally, sides moderately rounded; upper surface convex, densely squamose, with a faint central furrow and a row of erect setæ on each side of it. *Elytra* ovate, sides gently rounded, broadest about middle; upper surface convex, with fine punctured striæ; the intervals almost plane, with dense scaling and with single rows of remote, very long pale setæ on each interval except 4 and 6, which occasionally bear a few short setæ. *Legs* piceous, with dense pale opalescent scaling.

NATAL: Estcourt (*A. E. Haviland*); Frere (*G. A. K. M.*).

TYPE in the British Museum.

ZEUGORYGMA ORANGIÆ, sp. nov.

Long. 3–$4\frac{1}{4}$, lat. $1\frac{1}{2}$–$2\frac{1}{2}$ mm.

The description of *Z. hirta* applies entirely to this species, except in the following particulars:—The rostral scrobes are continued backwards from the fossa, and even when hidden by the scaling their upper edge may be seen in the form of a narrow

bare carina running from the antennæ more than halfway to the eye, there being no trace of this in *hirta*; the elytra also have their bases distinctly marginate and at the external angle there is a slight projection which just overlaps the base of the prothorax, both these characters being absent in *hirta*; finally, the antennæ are slightly more elongate, and the third joint of the funicle is distinctly longer than the fourth.

Orange Colony: Bothaville (*Dr. H. Brauns*). Cape Colony: Port Elizabeth (*Dr. H. Brauns*).

Type in the British Museum.

Dr. Brauns has kindly sent me a series of eleven specimens, in which the above-mentioned characters are quite constant.

Hipporrhinus mendicus, sp. nov.

Long. 15, lat. $6\frac{4}{5}$–$7\frac{1}{2}$ mm.

Head coarsely rugose and with scattered scaling; forehead almost plane, with a low central carina; anteocular furrows present. *Rostrum* separated from head by a transverse incision, moderately stout, curved and slightly dilated at apex; upper surface with a broad and distinct central furrow, the adjoining costæ coarsely punctured; upper lateral sulci broad and deep, uniting at base, the lower pair of equal length, but narrower, shallower, and not uniting; scrobes lateral, deep and straight; inferior basal furrow broad and deep. *Antennæ* with the scape scarcely reaching eye, the two basal joints of the funicle subequal. *Prothorax* as long as broad, apex narrower than base, sides moderately rounded, broadest about middle, apical margin distinctly rounded dorsally; ocular lobes well developed; upper surface convex, closely and evenly set with large conical granules, leaving a narrow but distinct central furrow containing no carina; granules bare, each with a short depressed dark seta, the interstices with dense brownish-grey scaling. *Elytra* oblongo-ovate, much broader in the ♀, broader than the prothorax at base (especially in ♀), the shoulders obtusely prominent; sides moderately rounded, broadest about middle, apical processes small and conical in both sexes; upper surface convex, with broad very shallow sulci containing rows of very small granules, the intervals with rows of more closely-set granules, those on intervals 3, 5, and 7 being much larger and more elevated, especially towards apex; the apices of the granules bare, the rest of the surface being densely covered with round greyish-brown scales. *Legs* notably short in ♀, much longer and thicker in the ♂; all the tibiæ curved (more strongly so in ♂) and coarsely dentate; posterior tarsi with the three basal joints subequal in length and breadth.

Cape Colony: Touw's River (*R. M. Lightfoot*).

Types, ♂ in the South African Museum, ♀ in the British Museum.

Allied to *H. gravidus* Mshl., but in that species the upper lateral sulci of the rostrum do not unite at the base, and the basal inferior furrow is much shallower; the shoulders of the elytra

are also much more oblique, and the scaling is different, being much thinner, with the scales large, round, and white.

HIPPORRHINUS IMPRESSICOLLIS, sp. nov.

Long. 12½, lat. 3½ mm.

Colour black, moderately shining, and entirely devoid of scaling, except for a small white spot at the extreme apex of the elytra.

Head convex, with scattered shallow punctuation; forehead with two faint longitudinal impressions; anteocular furrows deep. *Rostrum* about as long as head and prothorax, cut off from head by a dorsal incision; sides parallel to middle, thence gradually dilated to apex; upper surface convex, with five distinct narrow carinæ, the outer one on each side abbreviated apically, the basal margin impressed in the middle and obtusely elevated laterally; lateral sulci broad and deep, subequal in length, the upper pair only uniting at base; scrobes very deep, lateral, almost straight; inferior basal furrow very deep. *Antennæ* with scape scarcely reaching eye, the two basal joints of funicle equal. *Prothorax* a little broader than long, of equal width at base and apex; sides moderately rounded, broadest about middle, dorsal anterior margin truncate; ocular lobes feebly developed; upper surface almost plane, gradually elevated posteriorly and steeply declivous along the basal margin, closely set with low rounded tubercles, leaving a narrow central furrow which, owing to the posterior elevation, appears much deeper towards the base and contains a fine abbreviated carina; tubercles each with a very short depressed dark seta. *Elytra* elongato-ovate in ♂, shoulders rounded; sides very slightly ampliated, broadest before middle; apical processes absent; upper surface convex, with shallow sulci containing regular rows of distinct granules; all the intervals evenly raised, convex, with regular rows of depressed and often elongate granules, each bearing a very short depressed dark seta, except on the declivity, where the setæ are long and erect. *Legs* comparatively long and slender, with scattered dark setæ; posterior tarsi with the 1st joint longest and as broad as 3rd, 2nd rather narrower but as long as 3rd.

CAPE COLONY: Stellenbosch (*L. Péringuey*), Malmesbury (*R. M. Lightfoot*).

TYPE in the South African Museum.

In general facies this species most resembles *H. capensis* L., but its rostrum is much more slender and distinctly dilated at the apex; moreover, the gradual posterior elevation of the prothorax and its unusually deep central furrow will distinguish *impressicollis* from all its nearest allies.

HIPPORRHINUS MONILIS, sp. nov.

♂ long. 10–17, lat. 4–7; ♀ long. 11, lat. 5 mm.

Head convex, bare, with scattered large deep punctures; forehead plane and somewhat plicate; anteocular furrows, as seen from above, very deep. *Rostrum* a little shorter than prothorax,

deeply incised at base, gently curved, the sides parallel to beyond middle and slightly dilated at apex; upper surface convex, with five narrow undulating carinæ, the central one sometimes a little higher than the others; the two lateral sulci on each side narrow, deep, and of equal length; scrobes deep and lateral; inferior basal furrow very deep. *Antennæ* with the scape reaching eye, the first joint of funicle longer than the second. *Prothorax* as long as broad, sides subparallel from base to beyond middle, thence rapidly narrowed to apex, anterior margin truncate dorsally; ocular lobes well developed; upper surface slightly convex, densely and evenly set with large rounded granules and without any trace of a central furrow, entirely devoid of scaling. *Elytra* oblongo-ovate, much narrower in ♂, truncate at base, shoulders prominent and subrectangular, sides slightly rounded, broadest about middle; apical processes absent in ♂, very small in ♀. Upper surface convex, without any distinct sulci, the whole surface being densely covered with even and regular rows of large rounded granules; these granules bare, and each with a short depressed dark seta; the interstices entirely devoid of scales, except for a few along the extreme lateral margin. *Legs* rugose, with black setæ on the tibiæ and a few white ones on the femora; the inner edges of tibiæ strongly dentate; posterior tarsi with the three basal joints subequal in length and breadth.

NAMAQUALAND: O'okiep (*G. Warden*).

TYPES, ♂ in the South African Museum, ♀ in the British Museum.

Very nearly allied to *corpulentus* Gyl., which, however, has the rostrum shorter, thicker, and more strongly curved; the prothorax is also much larger in proportion to the elytra in *corpulentus*, the elytra are less elongate and jointly sinuate at the base with the humeral angles projecting forwards, whereas in *monilis* the base is truncate with the shoulders subrectangular.

HIPPORRHINUS DISPAR, sp. nov.

Long. $11\frac{1}{5}$–$11\frac{3}{5}$, lat. $4\frac{4}{5}$–$5\frac{2}{5}$ mm.

Head convex, with scattered fine punctuation; forehead with a deep central impression; anteocular furrows deep. *Rostrum* separated from head by a deep incision, as long as prothorax, strongly curved and moderately dilated at apex; upper surface almost plane, rugosely punctured in the central portion and with a broad smooth central carina; the lateral sulci broad and deep, the upper pair only uniting at base, the lower pair much shorter; scrobes deep and lateral; inferior basal furrow very broad and deep. *Prothorax* broader than long, apex scarcely narrower than base, sides strongly rounded, broadest at middle; apical margin faintly concave dorsally; ocular lobes moderate. Upper surface slightly convex, evenly set with small rounded tubercles, leaving a narrow central furrow containing no carina; tubercles bare, the interstices with a few scattered pale scales. *Elytra* oblongo-ovate, truncate at base, shoulders prominent and sub-

rectangular; sides scarcely rounded, subparallel to beyond middle; apical processes absent in both sexes; upper surface with broad sulci containing rows of large shallow punctures separated by small granules, the intervals all evenly raised and with regular rows of larger granules; granules bare, with short depressed black setæ, which, however, are much longer and erect on the declivity; the interstices with thin, very scattered, white scaling. *Legs* moderately slender, the posterior pairs of tibiæ not dentate internally; posterior tarsi with joints 1 and 3 of equal width, 2 a little narrower, 2 and 3 subequal in length, 1 distinctly longer.

Cape Colony: Sir Lowry's Pass and Ashton (*F. Purcell*).

Types, ♂ in the British Museum, ♀ in the South African Museum.

The two examples here associated present a very different appearance superficially, owing to the fact that in the ♀ the granules on the elytra are much larger and distinctly elevated; whereas in the ♂ they are small and much depressed, giving the insect an appearance very much like that of *H. caffer*.

A similar form of variation may, however, be observed in other species of the genus, such as *wahlbergi* Boh. &c., and in all other respects these examples are clearly referable to a single species.

Hipporrhinus foveolatus, sp. nov.

Long. $8\frac{3}{5}$–$13\frac{1}{2}$, lat. $3\frac{4}{5}$–6 mm.

Head convex and closely punctured on vertex; forehead flattened, more sparsely punctured, and with a distinct central fovea; anteocular furrows absent. *Rostrum* not incised at base, moderately stout, scarcely curved, slightly dilated at apex; upper surface with a shallow central furrow, rather deeper anteriorly, the adjoining costæ with a few setigerous punctures; upper lateral sulci complete, deep anteriorly but uniting very shallowly at base, the lower sulci much abbreviated; scrobes directed beneath base of rostrum; the inferior basal furrow shallow. *Antennæ* with the scape scarcely reaching eye, the first joint of funicle rather longer than the second. *Prothorax* a little broader than long, its length equal to the width at base, the apex slightly narrower; sides moderately rounded, broadest about middle, apical margin truncate dorsally; ocular lobes feeble; upper surface convex, closely set with small rounded tubercles, leaving an ill-defined central furrow containing a strong carina; tubercles bare, each with a very short depressed seta; the interstices with scattered large round white scales. *Elytra* oblongo-ovate, shoulders roundly prominent, sides subparallel from shoulders to beyond middle; apical processes very small and conical in both sexes; upper surface convex, with regular rows of large subreticulate foveæ, the intervals narrow, smooth and devoid of granules dorsally, but with traces of depressed granules laterally and on the declivity; black, shiny, with small scattered patches of large white scales and with a few minute depressed setæ. *Legs* moderately stout, with sparse white

scaling; the anterior tibiæ more curved interiorly in the ♂; posterior tarsi with the three joints subequal in length, the second a little narrower than the others.

CAPE COLONY: Bredasdorp (*H. Fry*).

TYPES, ♂ in the British Museum, ♀ in the South African Museum.

A somewhat distinct species, owing to its regularly and deeply foveate elytra. It comes, perhaps, nearest to *partitus* Gyl., but in that species there is no inferior basal furrow on the rostrum, the forehead is deeply excavate, and the elytra are more elongate and less distinctly foveate.

HIPPORRHINUS MONTANUS, sp. nov.

Long. 17½–18, lat. 7⅔ mm.

Head convex, with close deep punctuation on vertex; forehead more sparsely punctured, with two shallow impressions in ♂, which are obsolescent in ♀; anteocular furrows deep, converging dorsally. *Rostrum* not cut off from head at base, but much elevated dorsally, as long as prothorax only, thick, curved and strongly dilated apically; upper surface shallowly impressed towards apex, slightly convex in the basal half and with a deep central stria which vanishes anteriorly; lateral sulci deep, the upper pair much longer and uniting deeply at the base, lower pair not uniting, each forming a large triangular fovea; scrobes very deep, directed beneath base of rostrum, but not uniting; the inferior basal furrow being absent. *Antennæ* short and stout; scape scarcely reaching eye and coarsely punctured; funicle with first joint much longer than second. *Prothorax* a little broader than long, apex narrower than base, sides rounded, broadest rather before middle, anterior margin truncate dorsally; ocular lobes very prominent; upper surface slightly convex, somewhat closely set with rounded tubercles, leaving a central furrow containing a broad abbreviated carina; tubercles bare, each with a depressed dark seta, the interstices with grey scaling. *Elytra* subovate, similarly shaped in both sexes, shoulders prominent and subrectangular, sides slightly rounded, broadest about middle; apical processes obsolescent; upper surface convex, with regular rows of large reticulate foveæ, the intervals narrow, 1, 3, 5, and 7 being distinctly costate, smooth and devoid of granules, the remaining intervals depressed and transversely plicate, but irregular and sometimes indistinct; colour black, with sparse minute pale scaling. *Legs* stout, with very scattered pale scaling; the posterior tibiæ strongly dentate internally; the tarsi broad, the basal joints of equal width, but the second shorter than the first and third.

CAPE COLONY: Matroosberg (*Dr. Marloth*).

TYPES, ♂ in the British Museum, ♀ in the South African Museum.

This species will stand next to *delectans* Hbst., with which it agrees very closely in its rostral structure (except that the lower

lateral sulci do *not* unite at the base); it may, however, be easily distinguished by its convex forehead, the much greater development of the ocular lobe of the prothorax, and especially by the large subreticulate foveæ on the elytra.

HIPPORRHINUS PURCELLI, sp. nov.

Long. $12\frac{2}{5}$, lat. $5\frac{1}{2}$ mm.

Head deeply and rugosely punctured; forehead subplicate, broadly impressed, and with a short elevated central carina; anteocular furrows absent. *Rostrum* not incised at base, as long as the prothorax, scarcely curved, but sharply declivous at apex, broadly and regularly dilated from base to apex; upper surface rugosely punctured, with a broad smooth central carina which is continued right up to the base, the adjoining carinæ shorter, narrower, and lower; lateral sulci not uniting at base, the lower ones rather narrower than the upper, but of equal length; scrobes entirely lateral, straight and oblique; the inferior basal furrow absent. *Antennæ* with the scape just reaching eye, the two basal joints of funicle subequal. *Prothorax* transverse, apex and base of about equal width, sides strongly rounded, broadest at middle, anterior margin slightly sinuate dorsally; ocular lobes well developed; upper surface slightly convex, fairly closely set with low rounded tubercles, leaving a narrow central furrow containing a distinct but abbreviated carina; tubercles bare, with short depressed setæ, the interstices with grey scaling. *Elytra* oblongo-ovate, shoulders subrectangular, sides scarcely rounded, broadest about middle, apical processes obsolescent; upper surface without striation, but with rows of small granules in lieu of punctures; interval 1 with distant, small, depressed tubercles vanishing on the declivity, intervals 2 and 4 with only one or two larger rounded tubercles before middle, 3, 5, and 7 with closely-set rows of large elevated tubercles which are sharply conical except on the basal portion of the disk, interval 6 quite smooth; tubercles bare, with short depressed dark setæ, the interstices with a very few scattered pale scales. *Legs* rugose, except the central part of the femora which is smooth; the interior edges of all the tibiæ strongly dentate; the posterior tarsi with the three basal joints of equal width, the first a little longer than second or third which are equal.

CAPE COLONY: Sir Lowry's Pass (*F. Purcell*).

TYPE ♂ in the South African Museum.

CYCLOMUS ALGOENSIS, sp. nov. (Plate LXVI. fig. 6.)

Long. $6\frac{2}{5}$–$8\frac{2}{5}$, lat. $2\frac{3}{5}$–$3\frac{2}{5}$ mm.

Black, with fine grey setiform scaling.

Head closely and rugosely punctured throughout, and with sparse setiform scaling; eyes very prominent, lateral. *Rostrum* rather shorter than the head and similarly sculptured, scrobes

continued beneath the eyes in the form of a distinct narrow furrow. *Antennæ* long and slender, piceous, with very fine grey pubescence; first joint of funicle as long as the club. *Prothorax* slightly longer than broad, obliquely truncate at apex, steeply retuse at base which is not broader than the apex, sides rounded, broadest at middle, shallowly constricted and transversely impressed anteriorly; upper surface very convex, with even rugose punctuation and a high narrow central carina. *Elytra* ovate, narrower in ♂, shoulders sloping, sides rounded, broadest about middle; upper surface convex, not striate, but with regular rows of minute granules in lieu of striæ dorsally and with rows of punctures laterally; the intervals 1, 3, and 5 with rows of small tubercles, each of which bears a very short depressed seta, intervals 2 and 4 plane, often with abbreviated or interrupted rows of small granules, 6 and 7 more convex and usually granulate, the outer intervals plane and smooth. *Legs* long and slender, piceous, with pale pubescence; tarsi elongate, the third joint deeply bilobed; femora strongly clavate, the posterior pair almost reaching the apex of elytra in ♂, much shorter in ♀.

Cape Colony: Algoa Bay (*Dr. H. Brauns*).

Types, ♂ in the British Museum, ♀ in the Oxford Museum.

Cyclomus simplex, sp. nov. (Plate LXVI. fig. 7.)

Long. $5\frac{3}{5}$–$9\frac{3}{5}$, lat. $2\frac{2}{5}$–4 mm.

Colour black, with fairly dense, grey or light brown, long, recumbent pubescence.

Head very convex, coarsely and closely punctured, thinly pubescent; eyes short ovate, very prominent. *Rostrum* shorter than the head, coarsely punctured, the scrobes evanescent posteriorly, passing obliquely much below the eyes. *Antennæ* moderately slender, piceous, with fine long grey pubescence; the club longer than first joint of funicle. *Prothorax* broader than long, obliquely truncate at apex, strongly retuse at base, sides strongly rounded, broadest at middle, slightly constricted near apex; upper surface subdepressed, longitudinally rugose, without any central carina and with recumbent pale pubescence. *Elytra* ovate, subacuminate apically, shoulders rounded, broadest before middle; upper surface convex, with deep striæ containing rows of granules, the intervals broad and plane in ♀, narrower and more convex in ♂, but all evenly raised, finely coriaceous, devoid of tubercles and with long depressed pale pubescence. *Legs* comparatively stout, piceous, with long grey pubescence; third tarsal joint strongly bilobed.

Cape Colony: Grahamstown.

Types, ♀ in the British Museum, ♂ in the Oxford Museum.

This insect may be readily distinguished from all its congeners by its smooth even elytra.

I have received five specimens through Dr. Horn labelled "Natal," but the locality seems doubtful.

Six species of *Cyclomus* have been described previously, and the following synoptic table may help to distinguish them:

1.	(2.)	Third tarsal joint not bilobate; scrobes broad and deep, reaching right up to the eyes, their edges continued so as to form the ocular orbits ..... *C. simus* Wied.
2.	(1.)	Third tarsal joint strongly bilobate; scrobes foveiform apically, very shallow or even obsolescent behind, being continued as faint oblique lines well below the eyes.
3.	(4.)	Prothorax broad, quite plane, with a deep excision on each side about middle ..... *C. planicollis* Pér.
4.	(3.)	Prothorax convex, sides not excised.
5.	(14.)	Elytra with the alternate intervals elevated or tuberculate.
6.	(9.)	Eyes situated on the superior margin of forehead; prothorax not, or only obtusely, carinate.
7.	(8.)	Rostrum with a narrow central furrow ..... *C. boops* Boh.
8.	(7.)	Rostrum without a central furrow ..... *C. languidus* Boh.
9.	(6.)	Eyes lateral; rostrum without a furrow.
10.	(11.)	Prothorax without a central carina; eyes subpedunculate. *C. eminulus* Boh.
11.	(10.)	Prothorax with a very distinct narrow central carina; eyes prominent but never subpedunculate.
12.	(13.)	Tubercles on elytra bearing long erect setæ; legs covered with very long fine hairs ..... *C. dasypus* Germ.
13.	(12.)	Tubercles on elytra with very short depressed setæ; legs with short recumbent pubescence ..... *C. algoensis*, sp. nov.
14.	(5.)	Elytral intervals all perfectly smooth and of equal height. *C. simplex*, sp. nov.

C. simus Wied. has been redescribed by Pascoe (Ann. N. H. (5) xx. p. 354, 1887) under the name of *Exaetoderes scabripennis*.

MYORRHINUS LONGSTAFFI, sp. nov.

Long. $3\frac{1}{5}$–$3\frac{2}{5}$, lat. 2–$2\frac{1}{5}$ mm.

Colour entirely black, uniformly and fairly densely covered with light green scaling and closely set with short suberect pale setæ.

Head shortly conical, densely squamose; eyes depressed and closely approximated. *Rostrum* elongate, as long as head and prothorax, strongly and regularly curved, compressed dorsally towards base (there being a broad lateral furrow from the antenna to the eye), but flattened and slightly spatulate at the apex; upper surface not gibbous at the insertion of the antennæ, but with a short shallow central furrow at that part, basal portion punctate and squamose, apex and under surface bare shiny and impunctate; colour black. *Antennæ* inserted about middle of rostrum, black, with the base of scape dark ferruginous; scape moderate, slightly curved, gradually clavate and as long as funicle without the club. *Prothorax* transverse, truncate at base and apex, the latter shallowly constricted and much narrower than the base, sides strongly rounded, broadest about middle; upper surface evenly convex, with fine shallow punctuation concealed by the scaling. *Elytra* short, subglobose, their sides strongly rounded, broadest before middle; upper surface convex with fine distinctly punctured striæ, the intervals smooth and impunctate. *Legs* ferruginous brown, the femora darker; the latter with green scaling, tibiæ with depressed whitish setæ.

CAPE COLONY: East London (*Dr. G. B. Longstaff*).

TYPE in the Oxford Museum.

Nearly allied to *M. setarius* Fåhr., but in that species the setæ are inconspicuous, being much fewer and very minute; the rostrum and legs are also of a different colour, being testaceous yellow.

I have much pleasure in dedicating this species to Dr. Longstaff, who has kindly entrusted to me the Curculionidæ which he took during the recent visit of the British Association to South Africa.

RHYPAROSOMUS MASHUNUS, sp. nov. (Plate LXVI. fig. 8.)

Long. $4\frac{3}{5}$–6, lat. $1\frac{3}{5}$–$2\frac{2}{5}$ mm.

Colour black, with dark brown scaling and thinly covered throughout with stiff erect setæ; elytra with a common **V**-shaped pale marking behind middle (often abraded), and sometimes with a broad pale lateral stripe.

Head rugosely punctured; forehead plane, with a short deep central furrow and a shallower one on each side of it, all three being continuous with the rostral furrows. *Rostrum* shorter than the prothorax, broad, scarcely curved, its sides subparallel; upper surface with three deep continuous furrows of equal length, the central one being rather broader than the others, beyond these a short lateral basal stria. *Antennæ* piceous, the scape slender, abruptly clavate, sparsely setose; funicle with the two basal joints elongate, the first much longer than the second. *Prothorax* as long as broad in ♂, slightly broader than long in ♀, apical margin slightly rounded, ocular lobes distinct, basal margin strongly rounded, sides gradually dilated from base to beyond middle, abruptly narrowed at apex; upper surface almost plane, the lateral margins retuse, rugosely and confluently punctured throughout. *Elytra* elongato-ovate, much narrower in ♂, deeply emarginate at base, the basal angles projecting sharply forwards; shoulders oblique, with a very faint humeral tubercle, sides parallel from there to beyond middle; upper surface convex with shallowly punctured striæ, with the suture and alternate intervals more raised than the others but without any tubercles; the intervals rugosely punctured and each with a row of stiff erect setæ, which are more numerous on the elevated intervals. *Legs* with dark brown scaling, rarely with paler markings, and set with stiff erect setæ; anterior pairs of tibiæ very strongly curved near apex in both sexes, but especially in the ♂.

MASHONALAND: Salisbury and Marandella's (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

A common species, occurring round the roots of various low-growing plants. It is evidently allied to *R. inæqualis* Boh. (type missing), but, according to the description, that species differs in having a transverse row of three foveolæ on the thorax, the elytra are truncate at the base, and the raised intervals have rows of remote obtuse tubercles.

DIABATHRARIUS SETULOSUS, sp. nov. (Plate LXVI. fig. 10.)

Long. 5½–6, lat. 2–2½ mm.

Head strongly deflected, retracted and invisible from above when at rest; forehead convex, covered with dense brown or grey scaling and without any central stria; eyes broadly ovate, not acuminate inferiorly. *Rostrum* shorter than head, somewhat ampliated at apex, its upper surface almost plane, squamose uniformly with the head at base, bare and rugosely punctured at apex; antennæ ferruginous. *Prothorax* longer than broad, its sides scarcely rounded, broadest at base and gradually narrowed from there to apex, base deeply bisinuate, apex strongly and roundly produced above head, ocular lobes obsolete, gular sinuation very deep; upper surface convex, closely set with large subreticulate punctures and with a distinct complete central furrow; the sculpturing is, however, very largely concealed by a thick brown or grey indumentum; the larger punctures bear short thick erect setæ, which are more numerous and paler along the apical margin. *Elytra* jointly trisinuate at base, somewhat broader than the prothorax at the shoulders, which are sloping, sides subparallel to beyond middle; scutellum distinct, densely squamose but not prominent; upper surface convex, with rows of large separated foveolæ which are partly concealed by a thick greyish indumentum; the intervals narrow, plane, coriaceous, and with rows of short thick distant erect setæ, which are more numerous posteriorly and a number of which unite to form a prominent fascicle on the declivity of the third interval. *Legs* covered with thick grey or brown indumentum; tibiæ with two short stout teeth internally at apex; tarsi short and broad, fourth joint entirely absent.

MASHONALAND: Salisbury and Umtali (*G. A. K. M.*). TRANSVAAL: Shilouvane (*Rev. H. Junod*).

TYPE in the British Museum.

DIABATHRARIUS VELUTINUS, sp. nov. (Plate LXVI. fig. 9.)

Long. 8–8½, lat. 3¾–4 mm.

Head deflected, only a small portion visible from above when at rest; forehead convex, with a shallow central stria, densely clothed with golden-brown scales and with scattered yellow setæ; eyes narrowly ovate, but broadly rounded inferiorly. *Rostrum* about as long as head, straight, parallel-sided at base, very broadly and triangularly dilated on each side at apex; upper surface plane, rugosely punctured and with a narrow central carina; antennæ ferruginous, the club fuscous. *Prothorax* as long as broad, sides parallel from base for two-thirds of the length, then rapidly narrowed to apex, base bisinuate, apex roundly produced above the head, ocular lobes slight, gular sinuation very deep; upper surface convex, densely and evenly clothed throughout with large golden-brown scales which strongly overlap one another and with scattered depressed yellow setæ. *Elytra* jointly trisinuate at base, much broader than prothorax at shoulders, which are rounded

and very prominent; sides not rounded, broadest at base and very gradually narrowed towards apex; scutellum distinct, prominent, densely squamose; upper surface convex, with regular striæ containing rows of deep punctures more or less hidden by the scaling; the intervals plane, closely set with large rounded scales, which stand almost vertically and thus give the insect a velvety appearance; each interval has a row of pale depressed setæ; the colour of the scales is dark brown with a common **V**-shaped lighter mark behind middle, immediately followed by a broader similar mark of the ground-colour, the apex again being lighter; but in the cotype the whole ground-colour is much lighter, and thus only the darker posterior band is noticeable. *Legs* densely covered with golden-brown scales and with depressed yellow setæ; tibiæ dilated at apex, with a stout spine at the inner angle and a shorter one just above it; tarsi very broad and short, fourth joint entirely absent.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE in the British Museum.

HYPSOMUS PARVUS, sp. nov. (Plate LXVI. fig. 11.)

Long. $2\frac{1}{2}$–3, lat. $\frac{4}{5}$–1 mm.

Head globose, with dense brown scaling and closely punctured, without impressions or carinæ. *Rostrum* elongate, as long as the prothorax, cylindrical, gently curved, slightly elevated at base and separated from the head by a faint impressed line, with close punctuation and dense brown scaling throughout, and without carinæ or sulci; scrobes disappearing rapidly beneath the rostrum and continued to base, but not uniting there. *Antennæ* piceous, scape not reaching the eye; first joint of funicle thicker and rather longer than second, the remainder very short, subequal, but gradually widening apically. *Prothorax* longer than broad, subcylindrical, sides almost straight but slightly narrowed anteriorly, basal margin arcuate, apex slightly lobate, ocular lobes feebly developed; upper surface convex, very closely and evenly punctured throughout, with dense brown scaling and a narrow longitudinal white line on each side. *Elytra* elongate, basal margin jointly sinuate and not broader than the prothorax, the sides rapidly dilated to form a rounded humeral angle, thence subparallel to beyond middle and rapidly narrowed to apex, where each elytron is shortly and separately acuminate; upper surface subdepressed and very gradually declivous posteriorly, with regular and distinctly punctured striæ; the intervals rather narrow, scarcely convex and finely coriaceous; colour piceous, with dense even brown scaling, except along the extreme lateral margin, which is greyish white like the whole of the under parts. *Legs* densely squamose; first tarsal joint as broad as, but a little longer than, second, third rather broader, deeply bilobate; claws free.

ORANGE COLONY: Bothaville (*Dr. H. Brauns*).

TYPE in the British Museum.

A small narrow species, which, except for its smaller size, quite resembles in general facies its congeners *scapha* Boh. and *lembunculus* Boh. The former, however, which is the larger ($5\frac{1}{2}$ mm.), differs from both the other species in having two shallow furrows on each side of the rostrum above the scrobes; the scrobes also unite beneath at some distance from the base; further, the basal margin of the elytra is wider than the prothorax, the outer angles bearing a small blunt tubercle, and owing to a constriction just behind the base the margin is somewhat raised; finally, the thorax is more transverse and has the sides rounded. The present species is much more nearly allied to *lembunculus* ($3\frac{3}{4}$ mm.), but in that insect the rostrum is not elevated at the base, but is continuous with the head; the ocular lobes of the prothorax are well developed and there are three white stripes dorsally, the outer ones being much broader; the basal margin is not wider than the prothorax nor is it elevated, but there is no humeral prominence as in *parvus* and the shoulders are oblique.

H. scapha I have taken in Natal at Estcourt, and it was also found at Howick by Dr. F. Dimock Brown. *H. lembunculus* I have received only from Uitenhage, where it has been taken by Father O'Neil.

Bagous punctipennis, sp. nov. (Plate LXVI. fig. 12.)

Long. $6\frac{1}{2}$, lat. $2\frac{2}{5}$ mm.

Black, uniformly covered throughout with dirty grey scaling having the appearance of putty.

Head retracted, forehead with a very deep and broad central impression and with a rounded prominence above each eye. *Rostrum* rather long and slender, as long as prothorax, subdepressed, sharply deflected at one-third from base, sides parallel throughout; upper surface slightly convex and with a faint central carina; when the scaling is removed the surface is found to be piceous, very shiny and minutely punctured. *Antennæ* inserted well behind middle of rostrum, piceous, with the club grey, the scape very short. *Prothorax* longer than broad, basal margin arcuate, apical margin slightly lobate and somewhat elevated; sides subparallel from base to near apex and there sharply constricted; ocular lobes prominent; upper surface almost plane, with close faint punctuation and irregular wrinkling, with a mere trace of a broad very shallow central furrow and with a distinct lateral impression about middle. *Elytra* oblong, jointly sinuate at base, the margin being somewhat elevated and crenulated; shoulders sloping and with a sharp humeral prominence; sides almost straight and gradually narrowed posteriorly, apex slightly and separately produced and with a sharper prominence from the end of the third interval; upper surface almost plane on disk, with broad striæ containing rows of large round punctures, which are visible through the scaling to the naked eye, the intervals plane on disk and slightly convex laterally, 3 and 5 each with a sharp conical tubercle on the declivity, the latter being nearer the apex; interval 3 is also dentately carinate on the apical

half of the declivity, the carina forming a sharp prominence at the apex. *Legs* densely squamose, the tibiæ with sparse very long setæ; tarsi extremely slender, the three basal joints no broader than the fourth, the second joint slightly longer than the first.

PORTUGUESE E. AFRICA: Beira (*P. A. Sheppard*).

TYPE in the British Museum.

This very distinct species was caught by Mr. Sheppard at light. The very slender tarsi, the apical prominences, and the short scape and scrobe are all characters which will at once distinguish it from any of the other African forms.

BAGOUS BEIRANUS, sp. nov.

Long. $2\frac{3}{4}$, lat. 1 mm.

Colour black, with uniform dark brown scaling.

Head convex, forehead without any impression. *Rostrum* shorter than prothorax, curved and with its sides parallel; upper surface convex, smooth and with a short basal sulcus on each side above the scrobe. *Antennæ* inserted close to apex of rostrum, piceous. *Prothorax* as long as broad, arcuate at base, apical margin truncate dorsally, broadest before middle, the sides being gradually dilated from base to near apex and there sharply constricted; upper surface slightly convex, with subrugose confluent punctuation throughout. *Elytra* shortly oblongo-ovate, jointly sinuate at base, shoulders roundly prominent, sides almost parallel from base to behind middle, apex abruptly subacuminate; upper surface gently convex, subretuse posteriorly, with a small prominence on the fifth interval at the summit of the declivity, the striæ broad and deep and containing rows of large subreticulate punctures, which become smaller laterally and quite disappear on the declivity, the intervals very narrow and undulating on the disk. *Legs* black, with dense scaling, the tibiæ with a few long setæ on the inner edge; tarsi with joints 1–3 subequal in length and breadth, longer than broad, joint 4 much longer and scarcely narrower, joint 3 not lobate.

PORTUGUESE E. AFRICA: Beira (*A. Bodong*).

TYPE in the British Museum.

The facies is that of a small *B. cœnosus* Gyl., from which it may be distinguished by the anterior dilatation of the prothorax, the coarsely punctured striæ on the elytra, and the narrow undulating intervals.

BAGOUS HUMERALIS, sp. nov.

Long. $4\frac{3}{5}$, lat. $1\frac{2}{5}$ mm.

Head slightly convex, finely punctured; forehead with a shallow central impression. *Rostrum* shorter than prothorax and comparatively stout, strongly deflected close to the base; upper surface convex, smooth, and with a short basal furrow above the scrobe. *Antennæ* inserted at the middle of rostrum. *Prothorax* as long as broad, arcuate at base, apical margin subtruncate dorsally and slightly elevated, the sides gradually dilated from

base to beyond middle and sharply constricted at apex; upper surface slightly convex, rugosely punctured, and with a deep complete central furrow. *Elytra* only slightly sinuate at base, broadest at the humeral angles, which are rather sharply prominent, the sides subparallel from there to behind middle; upper surface slightly convex, with broad striæ containing rows of deep closely set punctures which are shallowly visible through the scaling; the intervals narrow, costate, the alternate ones distinctly more elevated, the fifth with a small prominence on the declivity. *Legs* piceous brown, the tibiæ with a row of long erect setæ on the interior edge; tarsi with the three basal joints subequal in length and breadth.

Cape Colony: Uitenhage (*Father O'Neil*).

Type in the British Museum.

This species has the appearance of a large *B. cœnosus* Gyl., from which it differs in its much shorter, thicker, and more sharply deflected rostrum; the scape and scrobe are also much shorter; the apical constriction of the thorax is stronger and the central furrow deeper; finally, in *cœnosus* the punctuation of the striæ on the elytra is much finer and invisible through the scaling, the alternate intervals are not raised, and the tibiæ have no long setæ.

Bagous senegalensis (Faust, i. l.), sp. nov.

Long. $5\frac{1}{2}$, lat. $2\frac{1}{2}$ mm.

Black, with uniform dense brown scaling.

Head convex; forehead with a large central fovea and without supraocular prominences. *Rostrum* about as long as prothorax, regularly curved, and slightly dilated at apex; upper surface convex, smooth, the punctuation hidden by the scaling, the lateral sulcus above the scrobe shallow and rather indistinct. *Antennæ* inserted nearer the apex of the rostrum. *Prothorax* as long as broad, bisinuate at base, apical margin subarcuate dorsally, sides subparallel from base to near apex and there sharply constricted; upper surface slightly convex, closely and distinctly punctured, without any central furrow, but with a number of irregular shallow impressions. *Elytra* subquadrate, faintly trisinuate at base, the humeral angles bluntly prominent; upper surface almost plane, with a broad shallow V-shaped impression near base and with fine striæ containing shallow punctures which are quite hidden by the scaling, the intervals being broad, plane, and closely punctured (beneath the scaling); intervals 3 and 5 each with a large rounded tubercle at the summit of the declivity. *Legs* with dense brown scaling; tibiæ denticulate internally, each denticle with a short erect seta; tarsi with joint 3 not bilobate, joint 1 longer than 2 or 3.

Senegal (*Pipitz—coll. Faust*).

Type in the Dresden Museum.

Allied to *B. fastosus* Hartm., but a distinctly larger and heavier

insect. It differs also in the following characters: the evenly raised intervals of the elytra, the larger tubercles, the more prominent humeral angles, the non-bilobate third tarsal joint, and the denticulate tibiæ. The last character does not occur in any other African *Bagous* with which I am acquainted.

BAGOUS PROMONTORII, sp. nov.

Long. $2\frac{1}{5}$, lat. $\frac{4}{5}$ mm.

Head convex, with dense grey scaling; forehead with a small central fovea. *Rostrum* about as long as prothorax, distinctly curved and slightly dilated from base to apex; upper surface convex, smooth, minutely punctured, and without any basal lateral sulcus. *Antennæ* inserted close to apex of rostrum. *Prothorax* about as long as broad, basal margin slightly arcuate, apical margin truncate, sides subparallel from base to beyond middle and evidently constricted near apex; upper surface slightly convex and quite smooth except for a small fovea in the centre of the base and a shallow transverse impression near the apex. *Elytra* short, subquadrate, subtruncate at base, shoulders roundly prominent, sides subparallel to beyond middle; upper surface almost plane, with fine striæ containing shallow punctures which are not visible through the scaling, the intervals plane dorsally, the fifth bearing a slight elevation on the apical declivity. *Legs* ferruginous, with thin grey scaling; tarsi with joint 3 not lobate, quite similar to 2, scarcely as long as broad, as broad as and a little shorter than 1, broader and much shorter than 4.

CAPE COLONY: Cape Town*.

TYPE in the South African Museum.

Resembles a small *B. cœnosus* Gyl. in appearance, but that species has a distinct central furrow on the prothorax, as well as a basal furrow on each side of the rostrum above the scrobe.

In addition to the five species of *Bagous* described above there are four others known from Africa. Of these the only one which I have not yet seen is *B. crispus* Faust, from the Congo (Ann. Soc. Ent. Belg. 1899, p. 408). *B. fastosus* Hartm. was described from Dar-es-Salaam (Deut. ent. Zeit. 1904, p. 391), and I have seen two specimens taken by Mr. P. A. Sheppard at Beira. *B. longulus* Gyl. is apparently widely distributed throughout S.E. Africa, occurring in Cape Colony, Natal, Mashonaland, and Beira; it is found commonly on the water-lily (*Nymphæa stellata*). Father O'Neil has taken a number of *B. cœnosus* Gyl. under a stone in a damp spot near Uitenhage, Cape Colony; the only other localities from which I have seen it are the Victoria Falls, where a single specimen was recently found by Dr. G. B. Longstaff, and Bothaville, O.R.C., whence I have received one example from Dr. Brauns.

* Since this description was written, Dr. K. M. Heller has kindly submitted to me two small beetles of the genus *Bagous*, from Lagos and Ashanti respectively, which I can attribute only to this species. They differ in being of slightly larger size and in having the prominence on interval 5 much more strongly developed and the alternate intervals slightly more raised posteriorly.

The nine species may be discriminated by the following characters:—

1.	(2.)	Upperside set with erect curled setæ..... *B. crispus* Fst.
2.	(1.)	Upperside entirely devoid of erect setæ.
3.	(4.)	Antennæ inserted behind middle of rostrum; elytra with a sharp prominence at apex of interval 3 and with the striæ deeply punctured; joints 2 and 3 of tarsi longer than 1..... *B. punctipennis*, sp. nov.
4.	(3.)	Antennæ inserted at or beyond middle of rostrum; elytra with no prominence at apex of interval 3; joints 2 and 3 of tarsi not longer than 1.
5.	(8.)	Striæ on elytra deeply and closely punctured, the punctures being distinctly visible through the scaling; tibiæ with a row of long setæ on their inner edge.
6.	(7.)	Prothorax without a central furrow; antennæ inserted near apex of rostrum; size small (under 3 mm.). *B. beiranus*, sp. nov.
7.	(6.)	Prothorax with a deep and continuous central furrow; antennæ inserted at middle of rostrum; size larger (over $4\frac{1}{2}$ mm.)..... *B. humeralis*, sp. nov.
8.	(5.)	Striæ impunctate or with fine or shallow punctuation, which is quite invisible through the scaling; tibiæ, at most, with very short depressed setæ.
9.	(10.)	Third joint of tarsi evidently bilobate..... *B. fastosus* Hartm.
10.	(9.)	Third joint of tarsi not bilobate.
11.	(16.)	Forehead with no supraocular prominence; elytra subquadrate; third joint of anterior tarsi not broader than second.
12.	(13.)	Tibiæ denticulate internally; third interval of elytra with a large rounded tubercle at the summit of the declivity; size larger (5–6 mm.)..... *B. senegalensis*, sp. nov.
13.	(12.)	Tibiæ not denticulate; third interval of elytra without any tubercle; size smaller (2–3 mm.).
14.	(15.)	Prothorax with a continuous central furrow; rostrum with a basal lateral sulcus above the scrobe..... *B. cœnosus* Gyl.
15.	(14.)	Prothorax with no central furrow; rostrum without a basal lateral sulcus..... *B. promontorii*, sp. nov.
16.	(11.)	Forehead with a small prominence above the eye; elytra elongate; third joint of anterior tarsi distinctly broader than second..... *B. longulus* Gyl.

PHACEMASTIX TRINOTATA, sp. nov.

Long. $4\frac{2}{5}$–$5\frac{1}{5}$, lat. $1\frac{4}{5}$–$2\frac{1}{5}$ mm.

Colour black, with very sparse white setiform scaling, the elytra with one apical and two basal patches of dense creamy-white scales.

Head closely punctured and with sparse white scaling beneath; eyes subcontiguous and occupying almost the entire upper surface in the ♀, more widely separated in ♂. *Rostrum* strongly curved, its sides subparallel, the basal half compressed, coarsely strigoso-punctate, squamose, and with a high smooth central carina ascending between the eyes; the apical half depressed, bare, shiny, and very finely punctured in ♀, more coarsely so in ♂. *Antennæ* ferruginous, with the club fuscous and about equal to the last four joints of the funicle. *Prothorax* slightly broader than long, broadest at base, sides almost straight and gradually converging to near apex, which is strongly constricted, base bisinuate, apical margin truncate; upper surface subdepressed, with deep close and subreticulate punctuation throughout and a very short smooth

central carina; colour dull black, with very sparse white scales above and much denser yellowish scaling on the under parts. *Elytra* jointly sinuate at base, broadest at the shoulders, which are roundly prominent and thence gradually narrowed to apex; upper surface flattened in the basal half but convex posteriorly, with deep strongly punctured striæ, the intervals narrow but plane and rugosely punctured; colour black, with very sparse white scaling, a subquadrate patch of dense creamy scaling at the base of intervals 2 to 4 and an elongate sutural patch near apex; under parts with dense creamy-white scaling. *Legs* black or piceous, evenly clothed with rather thin white scaling; all femora with a large sharp tooth.

MASHONALAND: Salisbury and Umcheki R. (*G. A. K. M.*).

TYPE in the British Museum.

PHACEMASTIX PARDALIS, sp. nov. (Plate LXVII. fig. 3.)

Long. $7\frac{1}{2}$–$8\frac{1}{2}$, lat. $3\frac{1}{2}$–$3\frac{3}{4}$ mm.

Colour dull black, with numerous large white spots, which are fewer on the thorax; underside with uniform dense white scaling except on the apical segments of the abdomen, which are black with three white spots.

Head subconical, closely and coarsely punctured, black, with a large subquadrate patch of white scales below each eye; eyes closely approximated above but not contiguous. *Rostrum* about as long as prothorax, distinctly curved, broadest at base and gradually narrowed to beyond middle, thence slightly widening to apex, apical portion flattened, shining, and with fine scattered punctuation leaving an impunctate central line with a short central stria between the antennæ; basal portion compressed dorsally, with a prominent shiny central ridge ascending the forehead between the eyes; the sides closely and coarsely punctured, but covered with dense white scaling. *Antennæ* black, with the base of scape red; the club ovate, very large, about as long as the last six joints of the funicle. *Prothorax* rather broader than long, sides somewhat rounded, broadest near base and gradually narrowed to near apex, where it is strongly constricted; upper surface almost plane, rugosely and evenly punctured throughout, without any central carina; dull black with the following white spots: two large lateral ones (subapical and median), both uniting with the inferior white scaling, then a sublateral longitudinal row of three smaller spots, and two small spots placed transversely in the centre of disk, with sometimes a similar pair behind and another pair in front of them. *Elytra* broadest at shoulders, which are roundly prominent and thence gradually narrowed to apex; upper surface plane, shallowly depressed near the scutellum, with broad striæ containing large deep punctures, the intervals plane and rugose; colour dull black, with numerous irregular, usually subquadrate, white spots, often forming transverse patches, and with a broad white apical patch

containing a few small black spots. *Legs* black, with dense white scaling, posterior pairs of femora with a black spot towards apex, tibiæ with apex and a central patch black; all femora armed with a large triangular tooth.

MASHONALAND: Salisbury and Umcheki R. (*G. A. K. M.*). MATABELELAND: Matopos (*P. A. Sheppard*), Plumtree (*Father O'Neil*).

TYPE in the British Museum.

PHACEMASTIX POULTONI, sp. nov. (Plate LXVII. fig. 2.)

Long. $6\frac{1}{5}$–$7\frac{1}{2}$, lat. $2\frac{1}{2}$–$3\frac{1}{4}$ mm.

Colour black, prothorax with a ring of sparse white or yellowish scaling round the entire apical margin and a small patch of similar scales at each basal angle; elytra dark red, with the base and apex broadly black and with two broad transverse bands of white scales, one at the extreme base and the other dividing the red from the apical black; under parts black, with more or less sparse white scaling, forming denser patches on the meso- and metasternum.

Head subconical, closely punctured; eyes large, convex and meeting dorsally in both sexes. *Rostrum* as long as prothorax, curved and strongly deflected, its sides subparallel; apical portion flattened, bare and coarsely punctured throughout; basal portion somewhat compressed superiorly, with three dorsal carinæ, the two outer ones uniting near base with the central one, which is more elevated and ascends the forehead, the sides rugosely punctured and with sparse white scaling. *Antennæ* dark ferruginous, with white setæ; the club fuscous, shorter, about equal to the last three joints of the funicle. *Prothorax* as broad as long, sides scarcely rounded, broadest at base and gradually narrowed to near apex, where there is a sharp constriction, base deeply bisinuate, apical margin shallowly sinuate dorsally; upper surface moderately convex, with deep subreticulate punctuation throughout and with only a trace of a central carina. *Elytra* jointly sinuate at base, broadest at shoulders, which are roundly prominent, and thence gradually narrowed to apex; upper surface almost plane, depressed near the scutellum, which is black, bare, and rugosely punctured; the striæ broad and deep, containing rows of large shallow punctures, the intervals not broader than the striæ, plane and coarsely punctured. *Legs* black, evenly covered with rather sparse depressed white setæ; all the femora with a large sharp tooth.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

It is with much pleasure that I dedicate this species to my kind friend Prof. E. B. Poulton, F.R.S., the Hope Professor of Zoology at Oxford, to whom I am deeply indebted for much invaluable aid in my entomological work.

P. baridioides Fåhr. is the only other described species of this genus, and has a strikingly different coloration from any of the foregoing insects.

APLEMONUS ZIZYPHI, sp. nov. (Plate LXVII. fig. 11.)

Long. 3–3¼, lat. 1¼–1½ mm.

Head porrect, elongate, subcylindrical, coarsely punctured except on extreme vertex, with a shallow impression between the eyes, black with a few sparse white depressed setæ; eyes lateral, round, subdepressed. *Rostrum* stout, subcylindrical, narrower, but a little longer, than head, not curved, but slightly deflected; upper surface coarsely punctured throughout and with depressed white setæ, except at extreme apex, which is smooth and shiny. *Antennæ* black, inserted behind middle. *Prothorax* longer than broad, truncate at apex and base, cylindrical, with a slight constriction near apex; upper surface convex, coarsely and evenly punctured, with a deep elongate median fovea at base; colour black, with sparse depressed white setæ. *Elytra* pyriform, much broader than prothorax at shoulders, which are obliquely prominent, sides strongly rounded, broadest well behind middle; upper surface very convex, gibbous, deepest behind middle, the posterior declivity very steep, with nine broad and deep striæ containing rows of strong punctures; the intervals broad and plane, coarsely coriaceous, and often with a faint central stria, but with no tubercles or carinæ; colour black, occasionally with a dark reddish tinge, with sparse depressed white setæ. *Legs* stout, black, punctate, and with scattered white setæ.

NATAL: Malvern (*C. N. Barker*), Estcourt (*G. A. K. M.*). MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE in the British Museum.

This insect feeds on various species of *Zizyphus*, as also does its congener *A. gibbipennis* Fåhr. This latter species has a very different appearance, owing to the elongate tubercles on the intervals of its elytra. *A. aurivillii* Fst. (Stett. ent. Zeit. xlix. 1888, p. 296—type in the Stockholm Museum) from Damaraland is very closely allied to *gibbipennis*, and differs only in its smaller size and in having the rostrum parallel-sided and not constricted at base.

EUOPS CYANEUS, sp. nov.

Long. 3, lat. 1½ mm.

Head subconical, dark blue, convex on vertex, and with distinct scattered punctuation; eyes brown, large, prominent and broadly united above. *Rostrum* a little longer than head, narrow at base and strongly dilated from there to apex, convex above, dark blue, closely and distinctly punctured; antennæ black, quite similar to those of *E. morio* Boh. *Prothorax* about as broad as long, sides slightly rounded, broadest rather behind middle, apical margin broadly rounded, much narrower than base, which is bisinuate and has a distinct narrow margin; upper surface very convex, dark blue, very shiny, evenly set with fine scattered punctuation and without any central furrow or carina. *Elytra* subquadrate, jointly sinuate at base, much broader than prothorax at shoulders, which are roundly prominent, sides straight,

broadest at shoulders and very gradually narrowed posteriorly; upper surface slightly convex, with regular rows of small but distinct punctures, the intervals broad, plane, and impunctate; colour dark blue, shining. *Legs* dark blue, finely punctured.

NATAL: Malvern (*C. N. Barker*).

TYPE in the British Museum.

Its shining blue colour will at once distinguish this insect from the only other described South African species, *E. morio* Boh., which is of a bronze-black colour and not nearly so shiny; the thorax is much more coarsely punctured, and the elytra have deep coarsely punctured striæ, the intervals being narrower and more convex. *E. semiviolacea* Fst. (Deut. ent. Zeit. 1895, p. 234, note) has the thorax less shiny and more strongly punctured; the intervals on the elytra are also much narrower and more convex.

BALANINUS NUBIFER, sp. nov.

Long. 6–7$\frac{3}{5}$, lat. 3–3$\frac{3}{5}$ mm. Rostrum ♂ 2$\frac{1}{5}$, ♀ 6 mm.

Colour dark ferruginous brown, densely but vaguely mottled with dark brown, light brown, and white scales.

Head globose, with dense greyish-brown scaling; eyes moderate, a little larger in the ♂. *Rostrum* slender, dark brown, bare; in ♂ subporrect and coarsely strigoso-punctate up to the insertion of antennæ, apical portion curved, smooth, and finely but distinctly punctured; in ♀, porrect for two-thirds its length, then gently curved, distinctly punctured as far as the antennæ, anterior portion finely punctate at the sides only. *Antennæ* brown, with the scape paler, inserted a little beyond middle in ♂ and a little behind middle in ♀; terminal joints of funicle slightly longer than broad, 7 conical, longer and broader than 6; club shortly ovate, the two basal joints transverse and transversely truncate, the second quadrate. *Prothorax* transverse, sides rounded, broadest behind middle, scarcely narrowed towards base, strongly narrowed anteriorly; upper surface finely coriaceous and without any carina; scaling dense, variegated brown, white, and grey above and laterally; prosternum uniform greyish white. *Elytra* ovate, broadest at shoulders, which are roundly prominent; sides scarcely rounded, rapidly narrowed to apex, especially in ♂; upper surface convex, with fine but distinctly punctured striæ, intervals plane and very finely coriaceous; scaling dense, irregularly variegated with dark brown, yellowish brown, and white; underparts uniform greyish white. *Legs* ferruginous brown, with dense pale scaling; all femora armed with a stout simple tooth, tibiæ strongly uncinate.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

BALANINUS FICORUM, sp. nov. (Plate LXVII. fig. 5.)

Long. 4$\frac{2}{5}$–5, lat. 2–2$\frac{2}{5}$ mm. Rostrum (in a straight line from base to apex) ♂ 2–2$\frac{1}{5}$, ♀ 3$\frac{3}{5}$–4 mm.

Colour ferruginous brown, scaling on thorax dark fawn on disc and paler at the sides, scaling on elytra dark fawn variegated with dark brown marbling and spots of white or pale fawn.

Head globose, closely punctured, with fawn-coloured scaling above; eyes comparatively small in ♀, distinctly larger and closer together in ♂. *Rostrum* elongate, moderately stout, strongly and regularly curved throughout, rufo-testaceous, bare, mandibles black; in ♂ strongly strigoso-punctate in basal half, apical half shiny and minutely punctured; much longer in ♀, strigoso-punctate to only one-fourth from base, apical half impunctate. *Antennæ* comparatively short, testaceous, with the club fuscous, inserted slightly behind middle in ♀ and slightly beyond middle in ♂; terminal joints of funicle short, scarcely longer than broad; club short ovate, the two basal joints transverse and transversely truncate, the second joint being quadrate. *Prothorax* transverse, sides strongly rounded, broadest behind middle, constricted at apex; upper surface with fine reticulate punctuation and a faint short central carina; scaling dense, dark fawn on disk, with sides and a spot in front of scutellum paler, prosternum white in the middle and dark brown laterally. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides slightly rounded and rapidly narrowed to apex, the striæ fine but distinctly punctured, the intervals plane and coriaceous; scaling moderately dense, fawn-coloured, marbled with dark brown and with scattered white or yellowish spots; scutellum white; under parts with rather thin whitish or yellowish scaling and a denser patch on the mesosternal epimera and at the apex of the metasternal episterna. *Legs* testaceous, with fairly dense yellowish scaling; all femora armed with a stout simple tooth; tibiæ distinctly uncinate.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

Found on a species of wild fig.

BALANINUS AURIVILLII, sp. nov.

Long. $4\frac{2}{5}$–$4\frac{4}{5}$, lat. $2\frac{1}{5}$–$2\frac{2}{5}$ mm. Rostrum ♂ $2\frac{1}{5}$–$2\frac{2}{5}$, ♀ 4–$4\frac{2}{5}$ mm.

Colour ferruginous, evenly covered with creamy white or pale yellow scales and with a broad transverse band of denser scaling on the elytra, behind middle, varying from pale to bright yellow.

Head globose, with dense creamy scaling above and below; eyes large, scarcely smaller in the ♀. *Rostrum* elongate, very slender, dark ferruginous; in ♂, subporrect to beyond middle, thence curved to apex, strigoso-punctate in the basal half and squamose close to base, apical half shiny and minutely punctured; in ♀, porrect for four-fifths of its length, then sharply curved downwards, base shiny and impunctate throughout. *Antennæ* elongate, slender, testaceous, with the club fuscous, inserted beyond middle in ♂ and well behind middle in ♀; terminal joints of funicle elongate, sublinear, 6 and 7 equal in length and

breadth; club elongate, the two basal joints obliquely truncate and a little longer than broad, the second joint slightly narrowed basally. *Prothorax* transverse, broadest at base, much narrowed and faintly constricted at apex, sides strongly rounded; upper surface finely and reticulately punctured, and without any central carina; scaling creamy white or yellow, rather sparse, but forming a dense narrow edging to the base of brighter yellow. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides slightly curved and rapidly narrowed to apex; upper surface convex, with fine punctured striæ, the intervals plane, coriaceous; scaling not very dense, cream-coloured, with a broad transverse band just behind middle of denser yellow scales and with similar denser scaling along the suture from the base to the transverse band; under parts squamose as above, the mesosternal epimera and metasternal episterna with denser brighter scaling. *Legs* ferruginous, with rather sparse pale scaling; all femora armed with a distinct simple tooth; tibiæ not uncinate.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

Found on a species of wild fig.

I have much pleasure in dedicating this species to the distinguished Swedish entomologist, Prof. Chr. Aurivillius, to whom I am indebted for his kind and valued assistance on several occasions.

BALANINUS BARKERI, sp. nov. (Plate LXVII. fig. 7.)

Long. $4\frac{1}{4}$–$5\frac{1}{2}$, lat. 2–$2\frac{1}{2}$ mm. Rostrum ♂ 3, ♀ $4\frac{1}{2}$–5 mm.

Colour black, with thin grey scaling and the following markings of bright orange: on thorax a central stripe and a basal lateral spot; on elytra a short sutural stripe and an interrupted transverse discal band; a transverse lateral band on meso- and metasternum.

Head globose, with dense grey scaling above and below in ♂, in ♀ the interocular space is orange; eyes very large in ♂, rather smaller in ♀. *Rostrum* black, bare, porrect to beyond middle; in ♂, sharply curved apically, moderately stout, strigoso-punctate in basal half, apical half minutely punctured; in ♀, very slender, gently curved apically, shiny and impunctate throughout. *Antennæ* long and slender, fuscous, with the scape and basal joint of funicle ferruginous, inserted well beyond middle in ♂ and with the scape equal in length to the first five joints of the funicle, inserted close to base in ♀ and with the scape very short, equal to the first joint of funicle only; terminal joints of funicle elongate and slender, club more elongate than in *B. aurivillii* Mshl., the two basal joints similar in size and shape, broad and obliquely truncate at apex and strongly narrowed basally. *Prothorax* transverse, sides strongly rounded, broadest behind middle, much narrowed anteriorly and slightly so behind; upper surface slightly convex, evenly coriaceous, with a broad central stripe of bright orange and a spot of the same colour at each basal angle in both

sexes: the ♀ also has a vertical lateral orange band close to apex and a central spot on the prosternum. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides scarcely rounded and rapidly narrowed to apex; upper surface with fine shallowly punctured striæ; the intervals plane and coarsely coriaceous, covered with fine grey scaling and having a short basal orange stripe along the suture, which also extends shortly along each side of the base; each elytron with a median transverse orange band extending from near the margin up to the third interval, but sometimes abbreviated or interrupted; under surface with a broad transverse lateral orange band on both the meso- and metasternum, and a lateral orange spot on the second abdominal segment. *Legs* black, with rather thin grey scaling; all femora armed with a sharp simple tooth; in ♂ the anterior femora have a fringe of long white hairs along the basal half of the under surface; tibiæ not uncinate, the anterior pair in ♂ strongly curved at apex and with a sharp median tooth.

NATAL: Malvern (*C. N. Barker*).

TYPES, ♂ in British Museum, ♀ in Oxford Museum.

I have much pleasure in dedicating this pretty and distinct species to my friend Mr. C. N. Barker, who has done so much to increase our knowledge of the insects of the Natal Coast. He informs me that he has found it feeding on a small thorny tree, known as the "Impafa" (*Zizyphus mucronata*).

BALANINUS DIVERSICORNIS, sp. nov. (Plate LXVII. fig. 9.)

Long. 3, lat. $1\frac{2}{5}$ mm. Rostrum ♂ $1\frac{4}{5}$, ♀ $3\frac{2}{5}$ mm.

Colour castaneous; scaling on thorax dark brown (sometimes with a slightly coppery reflection), with a central white stripe which is broader basally; scaling on elytra castaneous, with a clouding of white scales, which are denser laterally and round the scutellum.

Head globose, closely punctured and with sparse pale scaling; eyes comparatively small and distant, scarcely larger in ♂. *Rostrum* very slender, dark testaceous; in ♂, porrect in basal half, which is strigoso-punctate and sparsely squamose, apical half curved, bare and minutely punctured; in ♀, porrect for two-thirds of its length, then distinctly curved, bare and impunctate except at extreme base. *Antennæ* testaceous, inserted beyond middle in ♂ and well behind middle in ♀; joints 3–7 of funicle equal, very small, transverse and submoniliform; club extremely elongate, as long as the whole funicle; joint 1 elongate, longer than first joint of funicle, narrow and only slightly broadened apically; joint 2 of equal length, but distinctly narrower at base and strongly clavate apically, being closely appressed to the two very short terminal joints. *Prothorax* as long as broad, sub-conical, broadest at base and narrowed to apex, sides slightly rounded and with a faint constriction near apex; upper surface convex, evenly coriaceous throughout; scaling dense, dark chestnut-brown, with a pale central stripe gradually widening from apex

to base; prosternum with uniform white scaling. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides gently rounded and rapidly narrowed to apex; upper surface convex, with rather strong and distinctly punctured striæ, the intervals plane and coriaceous; scaling rather sparse, castaneous, the lateral margins and a large area about the scutellum dusted with white scales; the scutellum with dense, the under parts with sparse, white scaling. *Legs* testaceous with thin pale scaling; all the femora armed with a stout tooth which is denticulate internally; tibiæ not uncinate.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in British Museum, ♀ in Oxford Museum.

Found on a species of wild fig.

The aberrant form of the antennal club in this species is very remarkable, and owing to the unusual diminution of the funicular joints the slender basal joints of the club might at first sight be mistaken for a portion of the funicle. In all other respects the insect is a typical *Balaninus*, and this structure cannot be considered as having a generic value owing to the fact that a gradual development of the club in this direction may be traced through *B. aurivillii* and *B. barkeri*.

The foregoing five species of *Balaninus* all belong to the typical form of the genus characterised by the evident lateral angulation of the second abdominal segment, the strongly appendiculate tarsal claws, the widely separated intermediate coxæ, the basally porrect rostrum, and the excessive length of the latter organ in the ♀ sex only.

Of this group only a single South African species has been previously described, viz. *B. suturifer* Fåhr. The following key will perhaps facilitate the identification of the six species:—

1.	(2.)	Femora unarmed ..... *B. suturifer* Fåhr.
2.	(1.)	All femora armed with a strong tooth.
3.	(6.)	Second joint of antennal club strongly transverse; tibiæ uncinate.
4.	(5.)	Joint 7 of funicle much longer than 6, appressed to the club; size larger..... *B. nubifer*, sp. nov.
5.	(4.)	Joints 6 and 7 of funicle subequal, the latter not appressed to the club; size smaller ..... *B. ficorum*, sp. nov.
6.	(3.)	Second joint of antennal club longer than broad; tibiæ not uncinate.
7.	(12.)	Antennal club much shorter than funicle; femoral tooth simple.
8.	(11.)	Scape much longer than first joint of funicle.
9.	(10.)	Anterior tibiæ with no median internal tooth; prothorax without a central stripe of orange scales . *B. aurivillii*, sp. nov., ♂ ♀.
10.	(9.)	Anterior tibiæ with a sharp median internal tooth; prothorax with a central orange stripe..... *B. barkeri*, sp. nov., ♂.
11.	(8.)	Scape only as long as first joint of funicle... *B. barkeri*, sp. nov., ♀.
12.	(7.)	Antennal club as long as whole of funicle; femoral tooth denticulate internally ..... *B. diversicornis*, sp. nov.

Of the remaining *Balanini* described from South Africa, the majority will have to be assigned to the genus *Tinola* Pasc., of which the type is *Balaninus suturalis* Boh. This species has

been redescribed by Pascoe (Journ. Linn. Soc., Zool. 1886, vol. xix. p. 332), but fortunately under the same name as that given by Boheman.

EUDERES NATALIS, sp. nov. (Plate LXVII. fig. 6.)

Long. 7, lat. $2\frac{3}{5}$ mm.

Colour entirely dark red-brown, with sparse recumbent yellow setæ.

Head hemispherical, rugosely punctured, with a shallow impression between the eyes and with scattered depressed yellow setæ; eyes lateral, large, subdepressed and coarsely facetted. *Rostrum* as long as the prothorax, curved, narrowed from base to middle, apical half parallel-sided and somewhat depressed; upper surface bare, coarsely punctured at base but more finely towards apex. *Antennæ* ferruginous, with dense pale setæ. *Prothorax* transverse, apical margin slightly sinuate dorsally, base evidently bisinuate, sides subparallel from base to beyond middle, thence strongly narrowed to apex; upper surface sparsely setose, with large irregular shallow punctures, the intervals between which form depressed undulating longitudinal carinæ. *Elytra* oblongo-ovate, jointly trisinuate at base, which is a little broader than the prothorax, sides subparallel from base to about middle, thence narrowed to apex; upper surface convex, with deep striæ containing large oblong separated punctures, the intervals broad, plane, and rugosely punctured; setæ sparse, rather more dense round the scutellum and at the humeral angles. *Legs* ferruginous, with depressed yellow setæ; femora with a small tooth; tibiæ with four fine carinæ on the outer surface.

NATAL: Drakensberg (*G. A. K. M.*).

TYPE in the British Museum.

Nearly allied to *E. lineicollis* Wied., which, however, may at once be distinguished by its prothorax, which bears fifteen very distinct straight and smooth carinæ; the intervals of the elytra are also less closely punctured. In both species the anterior coxæ are only slightly separated and the prosternum is very shallowly excavate. *E. lineicollis* I have found in *Protea* flowers on Table Mt., and it is apparently confined to the Western Districts of Cape Colony.

EUDEROIDES, gen. nov. (Euderinæ.)

Head retracted, almost invisible from above; eyes large, elongate, lateral, coarsely facetted and widely separated above. *Rostrum* short, straight, deflected, slightly depressed and rounded laterally; scrobes deep, almost straight, oblique, reaching the eyes and not uniting inferiorly. *Antennæ* short, scape just reaching eyes; funicle 7-jointed, joints 1 and 2 elongate and conical, the former being a little longer and much thicker, 3–7 short transverse and closely set; club broadly ovate and evidently 3-jointed. *Prothorax* rather longer than broad, base bisinuate, apex broadly produced over the head, sides rounded; prosternum

with a broad deep furrow having elevated sides but not continued beyond the anterior coxæ, which are broadly separated. *Scutellum* small, punctiform. *Sternum* elongate, mesosternal process broadly truncate and deeply vertical anteriorly, metasternal epimera not upwardly produced. *Elytra* elongate, jointly sinuate at base, covering the pygidium, convex, with ten complete striæ. *Abdomen* with the segments truncate, 2 much longer than 3 and 4 together. *Legs* short, the posterior tibiæ only just exceeding the apex of elytra; femora stout, scarcely clavate, all armed with a strong tooth; tibiæ slightly curved at base, subcompressed, uncinate, not carinate externally, their corbels open, elongate and very oblique; tarsi with the third joint broadly lobate, claws strongly appendiculate.

Type: *Euderoides mossambica*, sp. nov.

In general facies this genus very closely resembles *Euderes* Schh., but differs in the following important particulars: the retracted head, the more widely separated eyes, the deep prosternal furrow, the broadly separated anterior coxæ, the non-carinate tibiæ and the obliquity of the corbels in the posterior pairs.

Euderoides mossambica, sp. nov. (Plate LXVII. fig. 4.)

Long. 8, lat. $3\frac{1}{5}$ mm.

Colour uniform piceous black throughout, with sparse depressed, golden setæ.

Head retracted, hemispherical, rugosely punctured and without impressions. *Rostrum* shorter than the anterior tibiæ, scarcely curved, gradually dilated from base to apex; upper surface slightly convex, shallowly punctate and with a narrow smooth central line. *Antennæ* short, dark ferruginous, with the club fuscous. *Prothorax* a trifle longer than broad, base bisinuate, much broader than apex, dorsal apical margin broadly and roundly produced over the head, sides moderately rounded, broadest about middle; upper surface almost plane, rugosely punctured throughout and with a fine abbreviated central carina. *Elytra* elongate, oblongo-ovate, jointly sinuate at base and there slightly broader than the base of the thorax; shoulders oblique, sides parallel from there to beyond middle; upper surface convex, with broad striæ containing shallow punctures, the intervals plane, finely rugose and with short depressed golden setæ. *Legs* rather short and stout, rugose and sparsely setose, all the femora armed with a short tooth.

Portuguese E. Africa: Beira (*P. A. Sheppard*).

Type in the British Museum.

Neiphagus mashunus, sp. nov. (Plate LXVII. fig. 10.)

Long. 9–12, lat. 5–$6\frac{1}{2}$ mm.

Head deeply and rugosely punctured, with scattered setiform

scaling, forehead flattened; eyes coarsely facetted. *Rostrum* rather longer than prothorax, gradually dilated apically, rugosely punctured throughout, with a shallow lateral furrow from insertion of antennæ to eye filled with pale scaling; scrobes short, oblique, rapidly disappearing beneath rostrum. *Antennæ* with the three basal joints of funicle elongate, 2 being the longest, 5–7 very short, 4 half as long again. *Prothorax* shorter than its width at base, subtriangular, broadest at base and rapidly narrowed to apex, its sides slightly rounded, base bisinuate, apex strongly produced above the head, and with small but distinct ocular lobes; upper surface rather convex and with a low blunt prominence on each side of disk before middle, deeply and rugosely punctured throughout and with brownish and yellowish setiform scaling, which is directed forwards. *Elytra* very broad, subquadrate, the sides slightly rounded, half as broad again as the prothorax at the shoulders, which are produced into a blunt prominence, base gently trisinuate; upper surface very convex and steeply declivous behind, with regular shallow sulci containing rows of large subreticulate foveæ, the intervals closely and rugosely punctured, rather convex, except the first which is plane; intervals 2, 4 and 6 each with three distant tubercles bearing tufts of erect black, or dark brown, setæ, the tubercles being so placed as to form three strongly curved transverse rows on each elytron; colour black or dark ferruginous, variegated with rather thin brownish or whitish setiform scaling. *Legs* comparatively slender, rugosely punctured and with dense pale setæ and scaling; anterior femora not dentate; anterior pairs of tibiæ slightly curved and with two sharp spurs above the apical spine; tarsi with the third joint much broader than the others, onychium elongate.

Mashonaland: Salisbury (*G. A. K. M.*), Umtali (*A. Bodong & G. A. K. M.*).

Type in the British Museum.

A very distinct species, differing from its congeners in its less angulated elytra, much thinner legs, unarmed femora and elongate onychium. In general appearance it comes nearest to *N. fascicularis* Pasc., a Central African species which has recently been taken by Mr. P. A. Sheppard at Amatonga's on the Beira Railway.

Pachyonyx niveus, sp. nov.

Long. 8, lat. 3 mm.

Head subglobose, closely punctured and with dense white scaling; eyes large, coarsely granulate and meeting inferiorly. *Rostrum* about as long as prothorax, subcylindrical and slightly curved; upper surface bare, shining and with small scattered punctures; colour castaneous. *Antennæ* inserted a little in front of middle, entirely light ferruginous. *Prothorax* a little shorter than the basal width, broadest at base, the sides gradually

narrowed to near apex where there is a broad constriction, base slightly rounded, apex broadly produced above the head; upper surface convex with four sharp discal prominences on the anterior part, the finer sculpturing being entirely hidden by very dense scaling; the entire underparts and sides, up to, and including, the outer half of the discal prominences, pure white; the central portion light brown, leaving a mere trace of a central carina in the middle and having a large T-shaped white marking on the basal half. *Elytra* oblong, jointly sinuate at base, much broader than prothorax at shoulders, which are sharply and obliquely prominent, sides straight and parallel to far beyond middle, apices separately produced into very short but sharp processes; upper surface convex, gibbous, deepest at shoulders and rapidly declivous posteriorly, with regular rows of deep foveolæ, the intervals somewhat uneven and with low rounded tubercles, the most prominent on each elytron being: a short curved basal row of three, a longer very oblique median row of three, a juxta-sutural tubercle on the summit of the declivity and a larger discal one on the declivity; the sculpturing is, however, largely hidden by dense snow-white scaling which covers the whole surface except the extreme apex, which is light brown, and a small quadrate dark brown patch round the scutellum, which is itself covered with light brown scales. *Legs* covered with whitish-brown scales and short depressed white setæ, the femora with a white band not far from apex.

Orange River Colony: Bothaville (*Dr. H. Brauns*). Matabeleland: Plumtree (*Father O'Neil*).

Type in the British Museum.

Its remarkable white coloration, the absence of fascicles on the elytra, and the thinner and less coarsely punctured rostrum will at once distinguish this insect from *P. affaber* Boh., hitherto the only other described South-African species.

Pachyonyx triangularis, sp. nov. (Plate LXVII. fig. 8.)

Long. $5\frac{1}{2}$–6, lat. $2\frac{1}{2}$–$2\frac{3}{4}$ mm.

Head subglobose, closely punctured and with sparse depressed fulvous setæ; eyes large, coarsely granulate and meeting inferiorly. *Rostrum* as long as prothorax, cylindrical, curved, dark piceous but becoming paler at apex, evenly and strongly punctured, bare, moderately shining. *Antennæ* inserted a trifle in front of middle, ferruginous. *Prothorax* rather shorter than the basal width, broadest at base, the sides rapidly narrowed to apex where there is a broad but shallow constriction, base rounded, apex broadly produced above the head; upper surface convex, with four blunt discal prominences on the anterior part, the posterior part with large shallow punctures more or less hidden by fine whitish-brown scaling, having a low bare central carina; the prominences clothed with denser yellowish-brown scaling. *Elytra* jointly sinuate at base, obliquely truncate at

apex, broader than prothorax at shoulders, which are rounded and very sloping, and from there very gradually narrowed to apex; upper surface convex, gibbous, deepest just behind shoulders and rapidly declivous posteriorly, with regular rows of large deep foveolæ; the intervals narrow, finely aciculate and without any trace of tubercles or fascicles; sculpturing partially hidden by fine scaling which is light brown on disk, becoming indefinitely paler towards apex, with a triangular yellowish-white patch round scutellum, and a large white triangular lateral patch, the base of which extends along almost the entire margin, the apex reaching the fifth stria. *Legs* punctate, covered with dense light brown scaling.

NATAL: Verulam (*G. A. K. M.*).

TYPE in the British Museum.

Apart from its very different coloration, this species differs from *P. affaber* Boh. in its very sloping shoulders (in the latter they are roundly rectangular), in its narrower and more finely punctured rostrum, in the absence of any tubercles or fascicles on the elytra, and the smaller and more regular foveolæ on the basal half.

P. niveus may be distinguished from the present species not only by its striking colouring, but also by its more elongate, parallel-sided and tuberculate elytra, which, moreover, are not so much produced apically as in *affaber* or *triangularis*.

ENDEUS FLORALIS, sp. nov. (Plate LXVII. fig. 1.)

Long. 3–3$\frac{2}{5}$, lat. 1$\frac{2}{5}$–1$\frac{3}{5}$ mm.

Colour entirely dark fulvous, with only the eyes black; evenly clothed with fine recumbent yellow pubescence, which is not, however, sufficiently dense to conceal the sculpturing.

Head convex; eyes rather prominent, the space between them about half the width of the rostrum. *Rostrum* as long as the prothorax in ♂, distinctly longer in ♀, subcylindrical, slightly curved, strigoso-punctate and finely pubescent above. *Antennæ* comparatively short and stout, inserted about middle in ♀, but well in front of middle in ♂. *Prothorax* much broader than long, strongly constricted close to apex, which is obliquely truncate, base much broader and subtruncate, sides strongly rounded, broadest behind middle; upper surface convex, with close distinct punctuation throughout. *Elytra* oblongo-ovate, comparatively broad (2$\frac{2}{5}$ × 1$\frac{3}{5}$ mm.), with fine distinctly punctured striæ, the intervals almost plane, finely aciculate; pubescence fine, quite recumbent and with a silky appearance. *Legs* with a stout tooth on all the femora, the anterior tibiæ strongly dilated towards apex.

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

MASHONALAND: Salisbury (*G. A. K. M.*).

I have found this species in the flowers of *Crinum*, *Protea*, and *Anona senegalensis*, and have also taken it flying at sundown.

ENDEUS BAUHINIÆ, sp. nov.

Long. 3–3$\frac{3}{5}$, lat. 1$\frac{1}{5}$–1$\frac{3}{5}$ mm.

Colour uniform dull ferruginous varying to flavous; eyes black; entire upper surface thinly clothed with short depressed golden yellow pubescence.

Head convex; eyes scarcely prominent, the space between them equal to about one-third the width of the rostrum. *Rostrum* as long as the prothorax in ♂, longer than that of *E. floralis* but otherwise similar. *Antennæ* rather more slender than in that species, inserted well before middle. *Prothorax* almost as long as broad, faintly constricted near apex which is obliquely truncate, base evidently broader and truncate, sides rounded, broadest behind middle; upper surface slightly convex, closely and distinctly punctured throughout. *Elytra* oblongo-ovate, more elongate (2$\frac{2}{5}$ × 1$\frac{2}{5}$ mm.), gently convex, with distinct and strongly punctured striæ, the intervals plane, faintly aciculate; pubescence short and recumbent, but distinctly coarser than in *E. floralis*, and thus without the silky appearance. *Legs* similar to those of *E. floralis* except that the anterior tibiæ are distinctly less dilated apically.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE in the British Museum.

Found on the leaves of a species of *Bauhinia*.

ENDEUS HISPIDUS, sp. nov.

Long. 2$\frac{1}{5}$–2$\frac{4}{5}$, lat. $\frac{4}{5}$–1$\frac{1}{5}$ mm.

Colour dark ferruginous, the suture and eyes black; legs and antennæ paler, antennal club fuscous; upper surface with short erect pale setæ which are longer on the elytra.

Head convex; eyes more widely separated, the intervening space being nearly as broad as the rostrum. *Rostrum* as in *E. floralis*. *Antennæ* more slender, inserted not far from apex in ♂. *Prothorax* a little broader than long, evidently constricted near apex, slightly broader at base, sides moderately rounded, broadest about middle; upper surface convex, with close even punctuation and fairly dense suberect pale setæ. *Elytra* oblongo-ovate, convex, with rather deep strongly punctured striæ, the intervals plane and almost impunctate, bearing regular rows of short erect pale setæ. *Legs* as in *E. floralis* except that the anterior tibiæ are not at all dilated apically.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Found on leaves of *Protea* and *Brachystegia*.

The only other described species of *Endeus* of which I am aware are *E. castus* Boh., from Sierra Leone (the type of the genus), and *E. parilis* Fst. (Deutsch. ent. Zeit. 1898, p. 28), from Cameroon. Of the latter I have seen no examples, but I examined the type

of *castus* at Stockholm a few years ago. The five species may be discriminated by the following characters:—

1. (6.) Elytra with recumbent pubescence, and without rows of erect setæ.
2. (5.) Prothorax much broader than long, the sides strongly rounded.
3. (4.) Anterior tibiæ strongly dilated towards apex; eyes approximated, prominent; prothorax strongly constricted at apex. *E. floralis*, sp. nov.
4. (3.) Anterior tibiæ scarcely dilated; eyes more distant, not prominent; prothorax only slightly constricted at apex. *E. castus* Boh.
5. (2.) Prothorax almost as long as broad, its sides only moderately rounded ..... *E. bauhiniæ*, sp. nov.
6. (1.) Elytra with rows of erect or suberect setæ.
7. (8.) Space between the eyes almost as broad as the rostrum. *E. hispidus*, sp. nov.
8. (7.) Space between the eyes only as broad as the scape of the antennæ ..... *E. parilis* Fst.

ACANTHORRHINUS CARINATUS, sp. nov. (Plate LXVII. fig. 12.)

Long. 8½, lat. 3 mm.

Head short, strongly punctured on vertex, forehead with a broad and deep central furrow which is continued on to base of rostrum. *Rostrum* about as long as anterior tibia, subcompressed, broadest at base and somewhat narrowed anteriorly, slightly curved; upper surface convex, finely and evenly punctured throughout, with a short deep central impression at base (continuous with that on head) and a short lateral impression in front of each eye; under surface with two longitudinal furrows uniting at base, but with no prominences; antennæ black, glabrous. *Prothorax* longer than broad, base rounded and much broader than apex which is truncate, sides subparallel in the basal half, then roundly narrowed and with a constriction at apex; upper surface almost plane, with very deep, subremote punctures leaving a smooth central line; colour dull black, bare. *Elytra* jointly sinuate at base, rather broader than prothorax at shoulders, which are sloping, and from there very gradually narrowed posteriorly, the apices separately rounded; upper surface slightly convex, with regular deeply punctured striæ; the intervals narrow and impunctate, the 2nd, 4th and 6th depressed, the others elevated and carinate; colour dull black, bare. *Legs* black, bare, strongly punctured; femora and tibiæ with a fringe of pale setæ along their lower edges.

NATAL: Malvern (*C. N. Barker*), Estcourt (*G. A. K. M.*). MASHONALAND: Salisbury (*G. A. K. M.*). PORTUGUESE E. AFRICA: Beira (*P. A. Sheppard.*)

TYPE in the British Museum.

A very distinct species owing to the alternate elevation of the intervals on the elytra; the fringe of setæ on the femora is also a character peculiar to it.

ACANTHORRHINUS ZAMBESIANUS, sp. nov.

Long. 10, lat. 4 mm.

Head subglobose, vertex convex, black, shining and with fine scattered punctuation. *Rostrum* slightly curved and not angulated, rather ascending the forehead at base, with a slight rounded dilatation above the insertion of the antennæ and gradually narrowed anteriorly, finely and closely punctured throughout, with a deep subtriangular central impression at base which is continued to the apex, in the ♂ as a deep narrow furrow, in the ♀ as a faint shallow stria; sides with a deep furrow from the eye to apex, but narrowly interrupted not far from base; scrobes produced anteriorly as a broad shallow furrow; underside with a broad central furrow, in the ♂ the carina on each side of it bears a short but distinct tooth in front of the antennæ, which is quite wanting in the ♀. *Prothorax* much longer than broad, broadest at base, very gradually narrowed to beyond middle, then more rapidly so to apex where there is a shallow constriction; upper surface slightly convex, black, bare, shining, with close, but fine and faint, punctuation throughout. *Elytra* jointly sinuate at base, broader than prothorax at shoulders, which are very sloping, and from there gradually narrowed posteriorly (less so in ♀); upper surface rather convex, with very deep and strongly punctured striæ; the intervals narrow, subcarinate, impunctate, the third rather broader than the others. *Legs* black shiny, almost impunctate; the tibiæ only with a fringe of yellow setæ along their inferior edges.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

Apart from its much smaller size and the obsolete punctuation on both surfaces, this species differs from *A. dregei* in its much straighter, slightly curved rostrum. The rostral tooth is also much smaller and does not curve forwards in the ♂; while the rostrum of the ♀ entirely lacks the two inferior tubercles which are present in *dregei*.

CYRTORRHINUS CASTANEIPENNIS Boh.

Sphenophorus castaneipennis Boh., Schh. Gen. Curc. viii. 2, p. 249 (1845).

Cyrtorhinus baridioides Lac., Gen. Col. vii. p. 293, note 1, pl. 76, f. 3 (1866)—colour variety.

Cyrtorhinus caffer Fåhr., Öfv. K. Vet.-Ak. Förh. 1871, p. 282.

Liocalandra nuda Chevr., Ann. Soc. Ent. Belg. 1881, p. 92—local race.

Polyaulax castaneipennis Boh., Chevr. Ann. Soc. Ent. Fr. 1885, p. 95.

When at Stockholm in 1902 I had an opportunity of com-

paring the types of *C. caffer* Fåhr. and *Sphen. castaneipennis* Boh., and there can be no question as to their specific identity.

The form *baridioides*, described by Lacordaire as the type of his genus *Cyrto(r)rhinus*, offers no structural difference whatever from the typical Natal form of *castaneipennis* and differs solely in the black colour of its elytra, a character which cannot be here regarded as of specific value. The form *nuda* Chevr., however, from Equatorial Africa presents a striking structural difference from the Natal type in the complete, or almost complete, absence of punctuation on the thorax and the intervals of the elytra; and at first sight it would appear to be a good and distinct species. But an examination of Rhodesian examples shows this character in an exactly intermediate condition, and as some specimens of *nuda* show distinct traces of punctuation it is only possible to regard that form as an extreme local race of the southern species. The occurrence of red elytra in the *nuda* form appears to be unusual, most specimens being of a rather intermediate piceous brown colouring; whereas in the south there is a sharp division between the black and red forms. In *nuda* the legs vary also from piceous to red, whereas in South Africa all the varieties have black legs only. The punctuation of the thorax does not diminish progressively northwards, for the most heavily punctured specimens I have seen come from Beira; and the Nyasaland examples appear generally to be intermediate between those of Rhodesia and Natal.

The two genera *Liocalandra* and *Polyaulax* founded by Chevrolat must be sunk as synonyms of *Cyrtorrhinus* Lac.

Notes on Synonymy &c.

Alcides (*mouffleti* Fst.), Ann. Soc. Ent. Belg. 1899, p. 14 = *A. glanvillei* Pér., Trans. S. A. Phil. Soc. 1885, p. 143.

(*Attelabus*) *carneolus* Pér., Trans. Ent. Soc. 1896, p. 188, is an *Apoderus*.

(*Rhynchites*) *algoensis* Pér., Trans. S. A. Phil. Soc. 1888, p. 176, is an *Attelabus*.

Synthocus (*sagittarius* Pér.), op. cit. 1885, p. 139 = *S. nigropictus* Pasc.

Ithyporus (*capensis* Boh.) = *I. stolidus* F., the type of the latter being in the British Museum (coll. Banks).

Brachycerus (*frontalis* Fåhr.), the type of which is in the Oxford Museum, = *B. hystrix* Schh. This name was applied by Schönherr to "*B. cornutus* Oliv." (nec L.), which was described and figured by Olivier from a specimen, still extant, in the Banksian collection.

Theates (*cristatus* Pér.), Trans. S. A. Phil. Soc. 1888, p. 163, pl. 3, f. 14 = (*T. magus* Auriv.), Ent. Tidsk. 1888, p. 153, t. 2, ff. 1–3 = *T. angusticollis* Wied. (*Brachycerus*).

(*Megaproctus*) (*zanzibarinus* Desbr.), C. R. Soc. Ent. Belg. 1891, p. 361, note 1 = *Stenophida* (*linearis* Pasc.), Journ. Linn. Soc., Zool. xix. 1886, p. 336 = (*Liocalandra*) *pygialis* Fairm., C. R. Ent. Belg. 1884, p. cxlviii.

(*Cychrotonus*) *vidnatus* Pasc., Journ. Linn. Soc., Zool. xi. 1871, p. 163, is a *Chaunoderus*.

Hipporrhinus (*bertinæ* Fst.), Stett. ent. Zeit. 1891, p. 385 = *H. varius* Fähr. In my revision of *Hipporrhinus* (Proc. Zool. Soc. 1904, i. p. 141) I erroneously attributed this species to the genus *Stramia* Mshl., but through the kindness of Dr. Heller, of Dresden, I have now been able to examine Faust's type.

Dr. Heller's kind assistance has also enabled me to clear up the following synonymy :—

(*Hypomeces*) (*impressicollis* Pér.) Trans. S. A. Phil. Soc. 1885, p. 125 = *Dereodus vagabundus* Fst., Ent. Nachr. 1885, p. 7 ; and (*H. modestus* Pér.) l. c. p. 126 = *Dereodus schönherri* Fst., l. c. p. 5. Faust's paper was published in March, while Péringuey's was only read on the 27th May. So far as I am aware the genus *Hypomeces* does not occur in Africa.

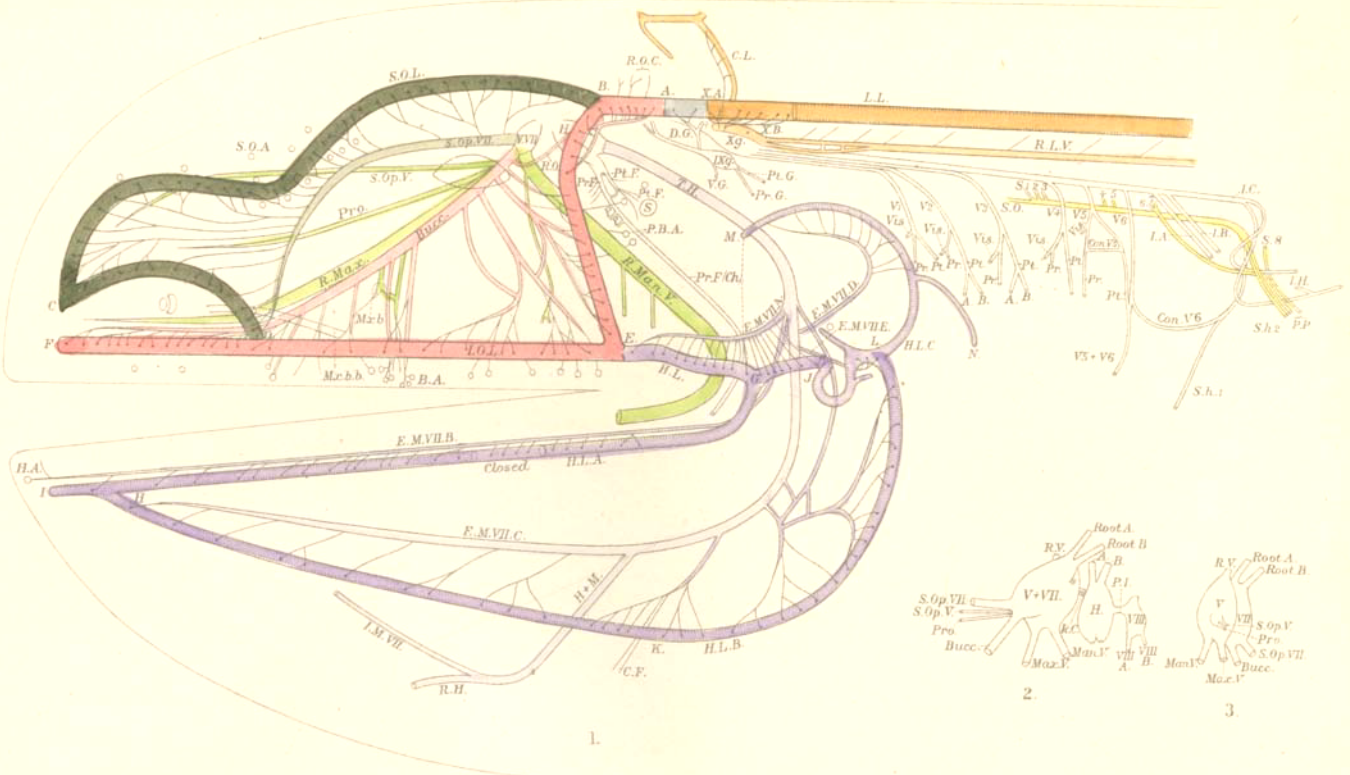
EXPLANATION OF THE PLATES.

Plate LXVI.

Fig.
1. *Ectatops sheppardi* ♀, p. 911.
2. *Strophosomus sulcatifrons*, p. 914.
3. *Strophosomus acuticollis*, p. 914.
4. *Rhinosomphus mutabilis*, p. 920.
5. *Systates dentipes* ♂, p. 921.
6. *Cyclomus algoensis* ♀, p. 930.
7. *Cyclomus simplex* ♀, p. 931.
8. *Rhyparosomus mashunus*, p. 933.
9. *Diabuthrarius velutinus*, p. 934.
10. „ *setulosus*, p. 934.
11. *Hypsomus parvus*, p. 935.
12. *Bagous punctipennis*, p. 936.

Plate LXVII.

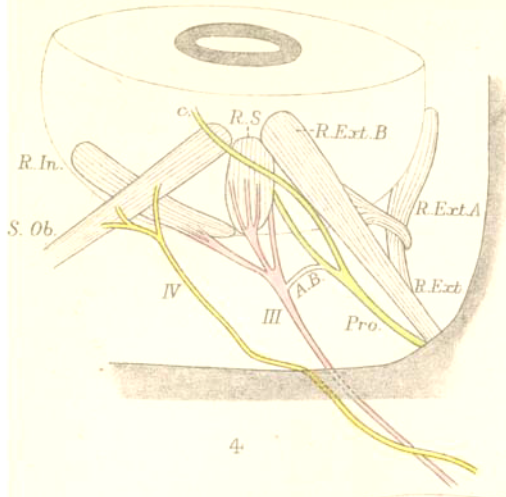
Fig.
1. *Endeus floralis*, p. 953.
2. *Phacemastix poultoni*, p. 942.
3. „ *pardalis*, p. 941.
4, 4 a. *Euderoides mossambica*, p. 950.
5, 5 a. *Balaninus ficorum* ♀, p. 944.
6. *Euderes natalis*, p. 949.
7. *Balaninus barkeri* ♀, p. 946.
8. *Pachyonyx triangularis*, p. 952.
9, 9 a. *Balaninus diversicornis* ♀, p. 947.
10. *Neiphagus mashunus*, p. 950.
11. *Aplemonus zizyphi*, p. 943.
12. *Acanthorrhinus carinatus*, p. 943.



O. A. M. H. del.

Bale & Danielsson, Ltd. lith.

CHLAMYDOSELACHUS. CRANIAL NERVES.



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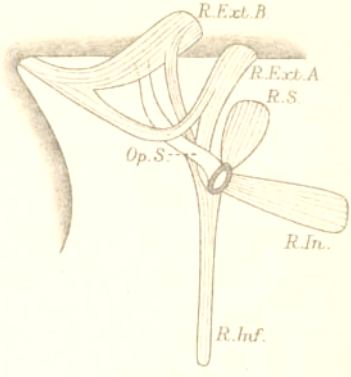

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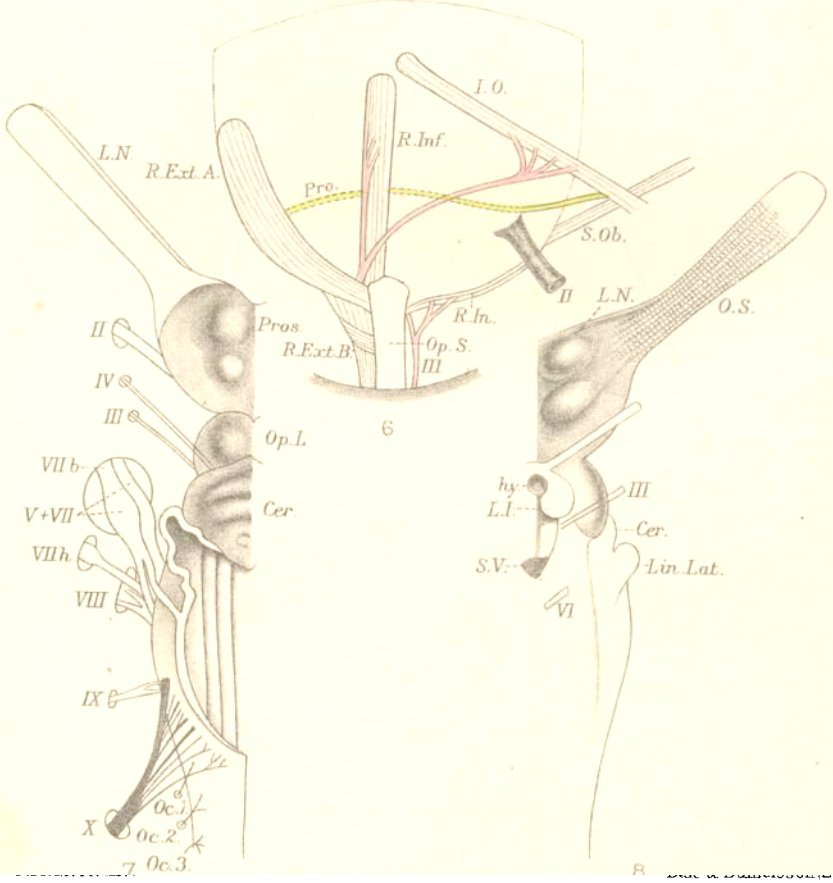

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CHLAMYDOSELACHUS. EYE-MUSCLES AND BRAIN.

3. The Cranial and Spinal Nerves of *Chlamydoselachus anguineus* (Gar.). By Mrs. O. A. Merritt Hawkes, M.Sc. (Zoological Laboratory University of Birmingham)*.

[Received November 8, 1906.]

(Plates LXVIII. & LXIX.†, and Text-figures 140, 141.)

Contents.

A. Introduction.

The following research was undertaken on the advice of Mr. F. J. Cole of Liverpool University, who, somewhat more than a year ago, sent me a specimen of *Chlamydoselachus anguineus* (♀), suggesting that I should dissect the cranial nerves. The specimen had been preserved in alcohol, but unfortunately the finer branches, or branches which were deeply situated, were not well preserved. Professor Bridge then kindly wrote for a formalin-preserved specimen (♂) from Japan, of which he allowed me to dissect the viscera and one side of the head. Mr. G. A. Boulenger, of the Natural History Museum, South Kensington, allowed me to examine the specimens in his charge and to dissect the last branchial arch of one specimen.

The alcohol-preserved specimen was in such a condition that microscopical work was quite useless. A number of stains were tried without success.

Unfortunately the cranium had not been opened in the formalin-preserved specimen, but it has been possible to do some partially successful microscopical work on the nerves. I am hoping later to continue this microscopical work in order to add to and verify

* Communicated by Professor T. W. Bridge, F.R.S., F.Z.S.

† For explanation of the Plates, see p. 990.

the results arrived at by the less reliable method of macro-dissection. The formalin had made the subcutaneous tissue so hard that thin sections of the skin have at present been impossible, hence the observations made by means of such sections on the lateral-line canals and the ampullæ of Lorenzini have not been satisfactory. I expect, however, to obtain better results in time.

Mr. Cole hoped that the nervous system of so low a species would throw some considerable light upon the nerve-component theory. The external relations of the nerves have proved of great interest, and have given some new and unexpected data, but the nervous system of *Chlamydoselachus* cannot be considered known until small specimens have been completely sectionised and the animal thus reconstructed.

Not only the nerves, but every part of *Chlamydoselachus* has proved of interest, owing to the combination of primitive and specialised characteristics. These points will, I hope, be eventually submitted to the test of embryological investigation.

A small bibliography only is appended, as a complete list of papers on nerves can be found in the works of Herrick, Cole, and Johnston.

I wish to heartily thank Professor Bridge for his continual help during the progress of this work and for his valuable revision of the MS.; Mr. Cole not only for the gift of the specimen, but for suggestions and help on the completed work. Thanks are also due to Professor K. Mitsukuri, of Tokio, who sent the *Chlamydoselachus* to Mr. Cole in order that its nerves and sense-organs might be investigated, and to Mr. G. A. Boulenger for references and for loan of books and for permission to examine the specimens in his charge.

B. The Lateral Line System.

The Lateral Line System comprises canals upon both the head and body, the former being much more complicated than is usual among Elasmobranchs (except Rays and Skates). The parts of the body over which the canals pass were the only relations Garman (**10**. p. 82) considered in naming the canals, and thus his nomenclature depends upon the apparent instead of the real relation of parts. As Garman's names are valueless in comparative anatomy, it is now necessary to rename the canals in accordance with Cole's method, *i. e.* with reference to the innervation. And as we may take it that a canal innervated by a well-defined nerve represents one unit of the system, this method of nomenclature brings analogous parts of the system of different species into line with one another.

The *Supra-orbital canal* (Plate LXVIII. fig. 1, B, C, D), which includes the cranial, rostral, and subrostral canals of Garman, and is innervated by the superficial ophthalmic branch of the Facialis, passes forward along the top of the head, just above the eye. Like all the closed canals of *Chlamydoselachus*, it lies immediately under the skin, from which it is not easily dissected. In front

of the eye, the canal bends outward towards the nostril, then curves upward and forward almost to the end of the snout, where it suddenly turns backward, passes above the nostril, and finally bends ventrad to join the Infra-orbital canal at D. In the supra-orbital canal of one specimen there were 55 neuromasts and openings on one side and 49 on the other. A second specimen had 41 on one side and 40 on the other. The sense-organs, as judged by the point of entrance of the nerve, are usually opposite the canal-openings in the supra-orbital as well as in the other canals. The openings may be at the end of short tubules, or on the canal itself. The longest tubules on this canal are less than 5 mm. in length, and these are found near the point of union with the Infra-orbital canal. Throughout the head-canals the neuromasts are placed at approximately regular distances (5 mm.) apart. According to Garman's figure (**10.** pl. xvii.) there is a canal uniting the anterior end of the Infra-orbital canal with the most anterior point of the supra-orbital canal. This additional canal is called by Garman, the prenasal canal. It was not present in the specimens dissected by me, and there was no trace of its openings in the specimens examined externally. From Garman's description it is not possible to determine whether the prenasal canal joins the infra-orbital. In Garman's figure (**10.** pl. xvii.) the supra-orbital (rostral and subrostral canals) curves forward much higher up the snout than in the specimens examined, in which case an additional canal would probably extend on to the snout. But it is improbable that this canal would join with the infra-orbital.

The *Infra-orbital canal* (A, B, E, D, F), which includes the occipital, orbital, orbito-nasal, and nasal canals of Garman, innervated by the buccalis and otic branches of the Facialis, begins at A as a direct continuation of the main lateral canal. It gives off the supra-orbital canal, and then passes downwards behind the eye. This portion is curved, the first third being directed forward and the remainder backward. The backward curve was probably produced by the lengthening of the jaws. At a point above the mouth (E), but not as caudad as the angle, the canal bends sharply forwards and runs along the upper jaw under the nostril to terminate at the median line, close to its fellow of the opposite side, from which it is separated only by a thin wall. In one specimen this canal had 52 neuromasts and openings on one side, and 50 on the other. In a second specimen the numbers were 47 and 46 respectively. The longest tubules in *Chlamydoselachus* occur on this canal, in the first part of its post-orbital ventral course. Here a few tubules reach a length of 1 cm.

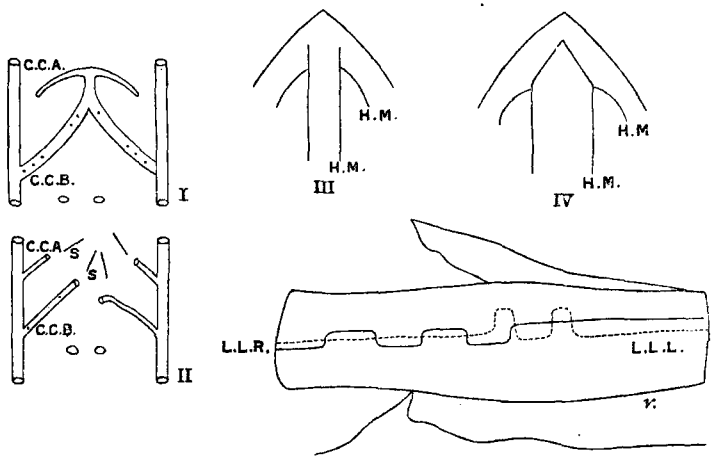
The *Hyomandibular canal* (E, G, J, L, K, I), which includes the angular, jugular, spiracular, oral, and gular canals of Garman (**10**), innervated by the external mandibular branch of the Facialis, is the most extensive and complicated part of the canal system. It branches out from the infra-orbital canal to run backwards above and beyond the mouth, with a somewhat tortuous

course, for a distance of 5 cm. This portion of the canal, which is closed, is probably the original hyomandibular canal, to which the other parts have subsequently been added. In one specimen there were here 15 neuromasts. Tubules are present in the first part of the canal only. Somewhat caudad to the mouth a branch (G, H, I) is given off, which, curving round the mouth, runs along the lower jaw to the symphysis (Plate LXVIII. fig. 1, H, L, A). This branch is an open canal, and in one case had 19 neuromasts. On the left side of one specimen 1 cm. of this canal was closed. It may be mentioned that in this closed region, although there were four neuromasts, there were no external openings corresponding to them. A second open canal (J, L, K, H) leaves the main hyomandibular canal at J. This branch (H, L, B) makes a wide curve downward and then forward to meet the last-mentioned canal at H, shortly before its termination. One side of one specimen had 42 neuromasts in this branch. In six out of the seven specimens examined externally, the hyomandibular canals of the two sides appeared to join at I. In the seventh specimen, however, the regions H, I, of the two sides were parallel and unconnected. Doubtless this was the original condition. The branch H, L, B, on one side of a single specimen, had a break of 1 cm. At first sight this break might seem to indicate that this was the point where the two branches G, H, K and J, L, K united, but when we see the canals in relation to their nerve supply, it is obvious that this cannot be the case. Undoubtedly the two canals met and united at H. There is a dorsal branch canal (L, M), narrow, shallow, and superficial, which curves upward and forward towards the lateral canal. In one specimen 10 neuromasts were present. One of the specimens had, on both sides, another small hyomandibular branch (N) and a curious partial twist in the region J, L, which terminated in a fine branch (O). Branches N and O are no longer functional. There is only a very slight depression in the skin, bordered by the usual triangular scales which functionally close the "open" canals. In the depression there is neither sensory tube nor neuromast. No nerve could be traced to these canals. It may be, however, that microscopical work would discover what macroscopical methods have failed to disclose. If these, probably degenerate canals occurred in a large number of specimens they would indicate that the canal-system of *Chlamydoselachus* in this region had become simplified by the partial atrophy of certain of its branches. As, however, these canals were found in only one specimen out of seven, they must, for the present, probably be regarded as an individual variation.

The *Commissural or Supra-temporal canal* (or canals), the aural canal of Garman, is placed, as noticed by Garman, anterior to the openings of the ductus endolymphaticus. It is never the usual straight, transverse canal connecting the right and left lateral canals. It varies considerably, as shown in text-fig. 140. There are indications of two instead of one commissural canal, but it is

impossible to state whether the present condition of these canals is vestigial or rudimentary. It is certain, however, that the condition of all the canals, but especially those in this region, is very unstable. The canals vary in their length, course, and diameter. The neuromasts, both as regards number and position, are very variable, but in every case they are supplied by dorsal branches of the lateralis vagi. In the specimen from which II. (text-fig. 140) was taken, lines (*s*, *s*) appeared to be drawn on the skin; these were found to be due to the scales, which were triangular in shape and arranged in two parallel interlocking lines, exactly as the scales are arranged above all the open canals. These "lines" may represent either the first step towards the formation of new canals or the last step in the degeneration of canals. The latter is the more probable, as if the former were the case we should expect to find neuromasts present, but so far neither neuromasts nor nerves have been traced.

Text-fig. 140.



Variations in Lateral Line Canals of *Chlamydoselachus*.

I., II. Commissural canal.
III., IV. Ventral view of Hyomandibular canal under the lower jaws.
V. Lateral canal in region of dorsal fin.
C.C.A., C.C.B. Anterior and posterior portions of Commissural canal.
H.M. Parts of Hyomandibular canal.
L.L.R., L.L.L. Lateral canal on right and left sides.

It is worth noting that the specimen from which II. (text-fig. 140) was drawn had also covering scales arranged in lines, dorsal to, and at right angles to, the lateral canal. These "lines" occurred at irregular intervals for a distance of 3 cm. The scales, which produced the appearance of lines, may be remnants of a condition in which the main canal had lateral branches. This

suggestion is perhaps confirmed by finding one such lateral branch, nearly 1·5 cm. in length, in the tail-region of another specimen.

The *Lateral canal* runs in the usual position from the head to the end of the tail, and is noteworthy owing to the fact that only the first inch is closed. The neuromasts occur at much more irregular intervals than is the case in the head-canals. In all the specimens examined there is a tendency in the region of the dorsal fin (text-fig. 140, V) to a departure from a straight line. In two specimens this tendency produced four distinct undulations. Similar undulations have been found in *Callorhynchus* (Cam. Nat. Hist., Fishes, T. W. Bridge, fig. 269, p. 470). In other cases the canal undulated slightly. No explanation of this phenomenon can be offered. This same region had on one side, in one specimen, a complete break of 5 mm. There was in this space no trace of canal or of covering scales. Garman also found curves and breaks on this canal in the tail-region.

The conclusion arrived at from these facts is that the lateral line system of *Chlamydoselachus* is primitive as regards (1) the open condition of a portion of the canals; (2) the cutaneous rather than subcutaneous position of the canals; (3) the entire absence of tubules in many places. In the occipital and hyomandibular regions, however, the system tends to a considerable complexity. Again there are indications, in the occipital and lateral canals, of either a vestigial or rudimentary complexity.

The innervation is an additional difficulty in the determination of the relations of this system. The lateralis branches of the Facialis present no difficulty, but if there are proved to be fibres of the ninth nerve innervating a few lateralis sense-organs, these must be regarded as an additional proof of the comparatively primitive nature of the system. The lateralis nerves in origin were probably related morphologically to a number of segments, and later became concentrated into the main trunks of the Facialis, Auditory and Vagus nerves. The fact that *Chlamydoselachus* has four lateralis roots, two for the buccalis, one for the external mandibularis, and one for the r. lateralis vagi, probably indicates a comparatively primitive condition for this system.

C. The Ampullæ of Lorenzini.

In *Chlamydoselachus* the anatomy and the arrangement of the ampullæ differ from those of the higher Elasmobranchs.

The anterior, latero-dorsad surface of the head, from the level of the eye to the end of the snout, is covered by ampullary openings which are divided into two groups by the Supra-orbital canal. The ampullæ of this whole region are innervated by the r. superficialis ophthalmicus VII. and are therefore probably homologous with the usual supra-orbital group of ampullæ. This group may, in *Chlamydoselachus* also, be called the supra-orbital.

A second group of ampullæ is found between the post-orbital portion of the infra-orbital lateral line canal and the spiracle. It

begins somewhat above the level of the eye, but does not extend quite as far ventrally as the level of the mouth. This group cannot be considered the equivalent of the mandibular ampullæ, for it is innervated by a number of small branches from the ramus buccalis. It may be called a postero-buccal group of ampullæ in order to bring its nomenclature into line with that of the other group innervated by the r. buccalis. This group may correspond to the occipital row of ampullæ in *Chimæra* (**3**. p. 655), parts of which were innervated by a branch of the r. oticus. There is in *Chlamydoselachus* no representative of the mandibular group. The latter may in Elasmobranchs have arisen as a caudad offshoot of the postero-orbital group, which, owing to its position, acquired a hyomandibular innervation. On the other hand, the mandibular group may have arisen independently of a group such as the postero-orbital, coincident with the disappearance of the latter.

A third, very diffuse group of openings occurs along the upper jaw immediately above the mouth. It extends from the anterior extremity of the head almost to the angle of the mouth. The group is innervated by numerous branches from the r. buccalis, and is no doubt homologous with both the outer and inner buccal groups of ampullæ of the higher Elasmobranchs, if we are to consider with Allis (**1**. p. 93) "that the surface ampullary pore represents approximately the place of origin of the ampullary organ." The group may be called the buccal group.

A fourth, very small group occurs at the symphysis of the lower jaw. The number of openings in this group varied from one to nine in the specimens examined. This group is innervated by a branch of the hyomandibular nerve, and represents the hyoid group of the Elasmobranchs.

It is evident, on close inspection, that what appears to be a single ampullary opening is in reality a group of openings placed closely together in an area devoid of scales. The number of openings in each group is usually four, but may be reduced to two or increased to six. When traced inwards each opening is found to lead into a thin-walled tubule, the tubules from each group of openings being united. Each tubule terminates in a number of ampullary pouches. A complete group is never more than 5 mm. long and lies almost parallel to the surface of the body. Each group is independent, so that the term "group of ampullæ" represents in this species a very different anatomical entity from what it does in the majority of Elasmobranchs. In *Chlamydoselachus* there are many superficial scattered groups of minute compound ampullæ, which together represent the usual, single deep-seated group of much longer simple ampullæ. The small groups here may be compared with those described by Collinge in *Chimæra* (**5**. fig. 9, B). The tubules are almost transparent, having very thin walls, consisting of a single layer of flattened cells. The cells pass gradually into the columnar cells which line the ampullary pouches. The latter cells have the granular

appearance of secreting cells. Each tubule ends in a group of ampullary pouches, which are joined with those of the other tubules into a compact mass. Unfortunately, it has not been possible to determine certainly whether the lumen in the pouch-region of each tubule remains distinct, or whether the lumina of this region of the tubules communicate. On the whole, the evidence indicates the former.

It is impossible to state the exact homology of these ampullæ with those such as are found in, say, *Læmargus*, as the development of both is unknown. But, judging from the work of Coggi, it seems possible that each compound group of ampullæ in *Chlamydoselachus* and in *Chimæra* is produced by what Coggi (**2.** p. 295) calls the "stadio di ampolla individualizzata," whilst *Læmargus*-like tubules are each produced by the direct development of one of the above "ampolla individualizzata." Hence, from the embryological point of view, each group of compound ampullæ in *Chlamydoselachus* may be regarded as the homologue of a single ampullary tubule such as is found in *Læmargus*, &c.

D. The Eye, Eye-muscles, and Nerves.

The eye is deeply seated in a socket, the external outline of which has the shape of a biconvex lens. There are both upper and lower eyelids, but no nictitating membrane. The infolding of the skin in both cases is sudden and distinct, that of the lower lid is remarkable for its depth, extending almost to the back of the eye. The infolded membrane both above and below the eye is deeply pigmented, the lower being also provided with fine scales. This pigmentation, which on the under side of the eye is as deep as that of the surface of the body, together with the presence of scales, indicates that the infolded portions become, at times (that is when the eye is protruded), a part of the superficial skin. Those portions of the inner surface of the eyelids which are never evaginated are quite smooth and of a light colour. The eye can easily be protruded, and when in this position does not look outwards but upwards, a position made possible by the large conjunctival fornix. It is known that *Chlamydoselachus* is a deep-sea fish, in which case an eye which could look upwards would be of the greatest advantage. This protrusible eye no doubt also explains the marked cephalad position of the optic nerve, which is thus placed because the movement is not only upwards but slightly anterior.

To keep the eye well out in the socket there is an optic stalk or rod of cartilage, common amongst Elasmobranchs (**12.** p. 25), which also serves here as a base of origin for the recti muscles. The eye-stalk is somewhat more than 1 cm. in length and about 3 mm. in diameter. It is attached to the side of the cranium, near the base, just in front of the trigemino-facialis foramen. The stalk is directed forwards in a curved line and ends in a flattened, enlarged knob which is applied to the inner

surface of the eyeball without, however, being attached to it. The *Torpedo*, for example, has an eye-stalk which differs considerably from that of *Chlamydoselachus*, inasmuch as it is attached to the cranium in a more anterior region of the orbit, is permanently fixed to the eyeball, and does not serve as a basis of attachment for any of the eye-muscles. The eye-stalk of *Torpedo* keeps the eye permanently protruded, while in *Chlamydoselachus* its function is two-fold—to prevent the eye sinking too far into the socket, and to supply a more lateral basis for the attachment of the muscles.

The *External Rectus* muscle consists of two parts which have separate origins and insertions. The two parts of the muscle are, however, not independent, for they are united by strands of muscle-fibres passing from one to the other. Division A (Plate LXIX. figs. 4, 5, 6, R.Ext.A) of the muscle is the smaller. Its origin is on the outer part of the optic stalk, its insertion on the posterior surface of the eyeball, *i. e.* the normal insertion of an undivided externus rectus. Division B (R.Ext.B) is twice as large as A. Its origin is from the basis cranii, just anterior to the auditory capsule and beneath the foramen for the ganglia of the trigeminal and facial nerves, as well as along the proximal part of the optic stalk. The insertion is on the dorsal side of the eyeball, somewhat more external than that of the rectus superior, which it partly overlaps. From the position of its origin and insertion, division B (R.Ext.B) must be considered as a secondary or derivative portion of the rectus externus. The innervation supports this view. The main portion of the sixth nerve passes over division B to end in small branches in A, whilst several small, but side branches are given off to supply B. This secondary muscle was probably split off from a normal external rectus and acquired a more proximal origin, to aid the rectus superior and the superior oblique in tilting the eye upwards. It seems almost to form a pair with this latter muscle. Another modification in connection with this rotation is the shortening of the rectus superior and the lengthening of the rectus inferior, the latter being almost three times the length of the former.

The *Superior* and *Inferior Oblique* muscles are both long and narrow. Their attachment is to the median anterior wall of the orbit immediately to the inner side of the orbito-nasal foramen. The superior oblique is attached a little more dorsally than its fellow, and is inserted nearly in the mid-dorsal line of the eyeball, close to the rectus superior and the B (R.Ext.B) division of the rectus externus. The inferior oblique is inserted nearly in the mid-ventral line of the eyeball near the rectus inferior.

The *Patheticus or fourth nerve* has its origin in the usual position, on the dorsal side of the brain, between the optic lobe and the cerebellum; it runs outwards and upwards to pass by a special foramen into the orbit, where it reaches the superior oblique muscle after a sinuous course.

The *Oculo-motor* arises from the ventral surface of the brain

between the optic lobes and runs outwards and slightly upwards to pass into the orbit through its own foramen. In the orbit it soon divides into the typical three branches, one branch going to the rectus internus, the second to the rectus superior, and the third dividing into a short and a long branch, of which the former supplies the rectus inferior and the latter the inferior oblique.

The *Recti Superior*, *Internus*, and *Inferior* are all attached to the top of the optic stalk, just below its flattened head. The rectus superior is a short wide muscle with a narrow attachment to the stalk and a wide insertion upon the eyeball. This muscle is inserted somewhat to the caudad side of the median line of the eyeball, and is partly overlapped by the superior oblique and the dorsal division of the rectus externus. The rectus internus is both longer and broader than the rectus superior. It passes under the superior oblique to be inserted on the anterior wall of the eyeball, more to the dorsal than to the internal side. It thus has a somewhat unusual insertion, and can therefore help in the extra pull given to the dorsal side of the eyeball, when the latter is twisted upwards. It will be seen from the figure (Plate LXIX. fig. 4) that the dorsal side of the eyeball has practically four, instead of the usual two muscles. The rectus inferior is longer and narrower than the rectus internus. It has a double attachment to the optic stalk, one immediately under the knob and the other, the smaller, at a distance along the stalk itself. This muscle is inserted into the eyeball in the median ventral line, to the inner side of the inferior oblique.

The eye of *Chlamydoselachus* has practically three groups of muscles: a dorsal group of four inserted near the angle of the eyeball; a posterior "group" of one inserted also near the angle; and a ventral group of two elongated muscles three times the length of the dorsal group, acting on the median ventral line, at a distance from the angle of the eyeball. The dorsal group is strengthened to move the eye upwards, while the ventral group merely pulls the eyeball back into the position of rest, and hence does not need to be so powerful.

E. The Trigemino-facial Complex.

The Trigeminal and Facial nerves are in parts of their course indistinguishable at first sight. This impression, although merely superficial, at the same time undoubtedly expresses a very strong tendency towards the union and confusion of these two nerves. No complete union between the nerves has been found, except for a distance of about 1 cm. on the left side, where a branch of the r. buccalis and of the r. maxillaris are inseparable. The appearance of union occurs chiefly in the region just beyond the orbit, where there are plexiform connections between the buccalis VII., mandibularis V., maxillaris V., and their branches. Here, when two or more nerves

come into close contact, they are loosely or tightly bound together by connective tissue, but, in all cases except the one mentioned above, in such a way that a separation can be effected by careful dissection. The smaller branches and these pseudo-unions vary considerably on the two sides of the same specimen and in different specimens. The variability, which is met with in every system of *Chlamydoselachus*, suggests that the species has considerable anatomical instability.

1. *The Trigeminal Nerve.*

The Trigeminal nerve originates by one broad root from the side of the medulla, at a lower level than the first and second roots of the Facialis, but on a level with the auditory and hyomandibular roots. This root is almost completely hidden in a side view by the buccalis ganglion. Shortly after the root leaves the brain it swells into the Gasserian ganglion, which is rounded on the inner, but flattened on the outer side, where it is covered by the buccalis ganglion (Plate LXVIII. figs. 2 & 3). The presence of one root only is surprising when it is known that both sensory and motor components are present. It is probable that serial sections would demonstrate two roots. On the inner side, somewhat anteriorly, there is a small swelling from which the profundus and the superficial ophthalmic V. are given off side by side as nerves of equal size, to pass forward parallel to one another for a short distance (Plate LXVIII. figs. 2 & 3).

The maxillary and mandibular rami are immediately given off from the end of the ganglion, there being no common maxillomandibular trunk.

(*a*) The *maxillaris*, the smaller of the two branches, passes obliquely downwards across the orbit, sending many branches ventrally. These, together with the branches into which the main nerve itself divides, supply somewhat more than the anterior half of the upper jaw with the associated tissues. The smaller maxillary branches divide into a great number of small branches at the outer part of the masseter muscle, over which the majority pass, to terminate just above the mucosa of the roof of the mouth and along the under and outer side of the upper jaw cartilage. Although this nerve does not usually contain communis fibres, the distribution of some of the above branches suggests that such may be present. No visceral branches have been found which might correspond with those of the maxillaris V. and mandibularis V. which Cole describes in *Chimæra* (**3**. p. 650). But the many small branches which terminate in the mucosa of the roof of the mouth probably consist of communis fibres, and therefore represent the visceralis branch of the maxillaris V. of *Chimæra*. Herrick, who in his *Menidia* paper regards the Trigeminus as a branchiomeric nerve, says (**13**. p. 414):—"The pretrematic ramus, or r. maxillaris, has typically only general cutaneous fibres;" .... "the absence of a prefacial fasciculus

communis and communis root of the trigeminus involves the lack of a r. palatinus for this segment. Functionally this is replaced by the forward extension of the r. palatinus VII." This statement is supported by Johnston, who says (**15.** p. 208) there is "no communis component in the Trigeminus and no viscero-sensory center in this segment." These statements are probably generally true, but there are some apparent exceptions to it, for in Amphibia, in *Amia*, in *Gadus*, in *Amiurus*, in *Chimæra*, and here in *Chlamydoselachus*, there are trigeminal visceral branches. It will, however, probably be proved in all these species, as it has been in *Amia*, that this communis component belongs to the Facialis, and has only secondarily become united with the Trigeminus. If the Trigeminus were a branchiomeric nerve we would expect to find a representative of the ramus visceralis, and as such we might have interpreted the visceralis elements which occur in the above-named species; but if, as Johnston says, the segment to which the Trigeminus belongs has no viscero-sensory centre and little or perhaps *no entodermal* area, this nerve cannot be branchiomeric at all, for a typical branchiomeric nerve should contain (**15.** p. 262) "a communis component distributed by way of the post-trematic, pre-trematic, and pharyngeal rami to the mucosæ" of its entodermal area.

(*b*) The *mandibular* branch, which is almost twice the size of the maxillary, passes obliquely backwards, giving off ventrally a number (3 or 4) of branches which supply the posterior half of the upper jaw, and must therefore be regarded as representing a portion of the maxillaris. On the caudad side, it sends off numerous small nerves into the masseter muscle. As the r. mandibularis passes along the lower jaw it sends more branches into the masseter muscle, which extends towards the mid-ventral line. At a point just before the insertion of this muscle a nerve is given off which soon divides into two equal branches: one of these supplies the perichondrium of the mandibular cartilage, whilst the other branch divides into numerous small branches which terminate in the skin near the symphysis. The mandibular ramus does not supply the large median muscles which lie in the angle made by the two sides of the lower jaw. The components in the mandibular ramus are motor and sensory (general cutaneous), the latter predominating.

It is somewhat exceptional for the maxillary and mandibular rami to come off directly from the Gasserian ganglion. Does the arrangement indicate (1) a primitive condition, or (2) a specialised condition due to the backward rotation of the angle of the jaw? Regarding the Trigeminus as a branchiomeric nerve, it must be borne in mind that the pre- and post-trematic rami come immediately from the ganglion, a condition still to be found in the Facialis and in many branchial nerves; later, the pre- and post-trematic branches tend to join for a short distance. The result of this union in the supposedly branchiomeric trigeminal nerve was to produce the usual maxillo-mandibular trunk. But in

Chlamydoselachus an intermediate condition is found, for the mandibular ramus has bound up with it a portion of the ramus maxillaris. If the upper and lower jaws in this species were of normal length it might be thought that maxillary and mandibular rami were taking the first step towards union, but on account of the great length of the jaws, which have undoubtedly considerably pulled back the mandibular as well as pushed back the hyomandibular and following nerves, it seems more probable that this backward extension of the jaw has either incompletely torn apart the maxillary and mandibular rami or prevented their complete union. If, however, the Trigeminus is to be regarded as of cerebro-spinal rather than of branchiomeric type, it might be considered as primitive indeed, consisting of a dorsal sensory ramus (r. maxillaris) and a ventral mixed ramus (r. mandibularis); but again, when we consider the influence of the specialised jaw, we have as much ground for supposing that the jaw has produced a splitting of a common sensoro-motor trunk as that the condition now found is a remnant of a primitive state in which each cerebro-spinal "nerve" was represented by two distinct rami.

(*c*) The *profundus* nerve, or ramus, originates, as stated above, from a small enlargement on the inner side of the Gasserian ganglion; hence, as in *Chimæra* (**3**) and *Petromyzon* (**16**), there is undoubted evidence that, at the present time, the profundus is a branch of the Trigeminus, although in origin it belongs to a more anterior segment (**15**. p. 206). On entering the orbit the nerve passes between the large rectus externus muscle and the cranial wall, sending dorsally a long ciliary nerve which ends around the upper part of the eyeball. The main nerve then passes outward, parallel with the oculo-motor nerve, to which it sends or from which it receives an anastomosing branch. Five mm. beyond the origin of the ciliary branch the profundus passes somewhat ventrally between the eyeball and the external rectus muscle to disappear in the eyeball, near the point of insertion of the ventral part of the external rectus muscle. The profundus passes for about 1 cm. under the covering membrane of the eyeball, emerging near the point where the optic nerve originates from the eyeball. The nerve then passes anteriorly and out of the orbit immediately to the outer side of the attachment of the inferior oblique muscle. Almost at once the nerve divides into a number of branches, which spread over the olfactory capsules immediately below the skin. No motor fibres were found in this region. No fusion with the superficial ophthalmic facialis (as in *Chimæra* and other cartilaginous fishes) has been found, nor with the superficial ophthalmicus trigeminus (as in *Amia*). In *Petromyzon* (**15**) Johnston states that one complete branch of the profundus is derived from the VIIth ganglion, and "would correspond with the typical ramus ophthalmicus superficialis VII." of Selachians. He also found a second branch, of which the fibres are supposed to be derived from the trigeminal ganglion;

this branch he considers "would correspond to the ramus ophthalmicus superficialis V. of Selachians" (**15**. p. 157). This being the case, the profundus of *Petromyzon* combines the conditions found both in *Chimæra* and *Amia*. Perhaps microscopical work would show some connection between these nerves in *Chlamydoselachus*, unless, indeed, the condition of the profundus is here more primitive even than in *Petromyzon*.

The anastomosing branch (Plate LXIX. fig. 4) between the profundus and oculo-motor nerves, mentioned above, is interesting in its relation to the theory that the latter is the motor representative of the primitive profundus nerve, for it may represent a connection which originally existed between these two nerves. But if this relationship does not exist, what may this connection signify? May it not be suggested that, as the radix brevis has not been found and may not be present, this connection between the profundus and oculo-motor nerves represents the fibres which connect the ciliary ganglion and the oculo-motor nerve, which here pass not directly to the ciliary ganglion, but by way of the profundus nerve?

(*d*) The *superficial ophthalmic* V. passes from the Gasserian ganglion side by side with the profundus nerve, which it equals in size. It at once passes dorsally and enters the same groove as the superficialis VII., with which, however, it does not unite. About as far forward as the external nares, but nearer the median line, it spreads out into many branches, which lie immediately under the skin. This nerve apparently contains only cutaneous elements, and hence has "the primary composition of this nerve" (**13**. p. 365). The condition of the s. ophthalmic V. in *Chlamydoselachus* is similar to that found by Cole and Dakin (**4**) in one specimen of *Chimæra*, where the ophthalmicus superficialis trigemini was in no way connected with the ophthalmic VII., and arose "from the main trunk of the trigeminus."

II. *The Facialis Nerve.*

The *Facialis* is made up in *Chlamydoselachus*, as in all fishes, of two distinct and yet united parts, the lateralis element and the usual factors of a branchiomeric nerve; of these parts the former is the more obvious, for the branchiomeric branches are of comparatively inconsiderable proportions. The anterior part of the Facialis, which consists of the buccal ganglion and of two nerves, the ramus superficialis ophthalmicus facialis and the ramus buccalis, is entirely lateralis. The posterior portion of the Facialis consists of the truncus hyomandibularis, which contains a large lateralis element as well as parts of a branchiomeric nerve.

The buccalis ganglion (Plate LXVIII. figs. 2 & 3), which overlies and is partly united to the Gasserian ganglion, arises by two roots of approximately equal diameter: of these one (A) is more anterior and somewhat more dorsal in position and also longer than the other (B), which arises just above the roots of the

t. hyomandibularis. On the inner and caudad side the trigemino-facial ganglion sends three fine nerve-strands to the hyomandibular ganglion. There is to the naked eye no indication of a separate ganglion for the superficialis ophthalmicus VII., which is given off at right angles from the anterior end of the composite ganglion. Roots A and B, which are undoubtedly lateralis, give rise to the buccalis and ophthalmic-facialis rami, whereas the corresponding roots of *Chimœra* (**4**) give rise not only to these lateralis nerves but also to the external mandibularis. It will be interesting to know whether in *Chlamydoselachus*, as well as in *Chimœra*, each of these lateralis rami is made up of fibres from both roots.

(*a*) The *superficialis ophthalmicus* VII. passes forward and slightly upward. The nerve lies at first in a groove in the cartilage, but soon this groove becomes a complete canal. At frequent intervals from the very origin, the nerve gives off branches to the supra-orbital lateral line canal. When, somewhat beyond the anterior wall of the orbit, the nerve makes a bend outwards, it sends off a great number of branches to supply the two groups of supra-orbital ampullæ of Lorenzini and the neuromasts in the anterior loop of the supra-orbital canal. The main nerve here bends downwards to supply the last 15 neuromasts of the supra-orbital canal.

(*b*) The ramus *buccalis* originates from the inner posterior angle of the buccal ganglion. It passes obliquely downward and forward across the orbit and the side of the head, towards the mouth in the region of the external nares. Beginning at its origin, the nerve gives off many small branches, which pass backward and downward to supply the neuromasts of the infra-orbital canal. There are about eleven principal branches, nearly all being distributed both to ampullæ of Lorenzini and to neuromasts. The first branch is probably the equivalent of the ramus oticus (Plate LXVIII. fig. 1, R.O.). It passes upwards and caudad, and divides into two branches outside the orbit, one of which supplies the first neuromasts of the infra-orbital canal, while the other bends outwards to supply neuromasts in the post-orbital portion of the same canal. Two minute branches (Plate LXVIII. fig. 1, R.O.c.) were traced to the skin, so that the ramus oticus contains general cutaneous fibres. Herrick thinks that the r. oticus is the dorsal branch of the Facialis, to which lateralis fibres have been added, and that the presence of cutaneous fibres determines the identity of this ramus. From the relations of the r. oticus to the buccalis—a lateralis ganglion—it seems more probable that the ramus was primitively lateralis, and that to it cutaneous fibres have been added. Should we not be more likely to find the dorsal branch of the Facialis in connection with the other portions of the true facial nerve? If the term r. oticus is to be confined to a ramus which supplies neuromasts in the first portion of the infra-orbital canal but does not supply any neuromasts in the descending post-orbital part of

that canal, then this ramus in *Chlamydoselachus* is equivalent to the *true* ramus oticus *plus* a few more nerve-fibres. The r. oticus does not supply all the sense-organs which occur in the region of the canal anterior to the commissural canal, but apparently two of these are supplied by a dorsal branch of the Glossopharyngeus and the remainder by a dorsal branch of the Vagus.

The branches of the ramus buccalis are arranged approximately in two groups: one group being associated with the maxillary branches of the mandibularis V., and the other with the branches of the maxillaris V. The branches not only supply the diffuse group of ampullæ which occurs above the mouth, but also a group which lies between the descending portion of the infra-orbital canal and the spiracle. This group is not usually represented in Elasmobranchs. It is noteworthy that each of the branches supplies both ampullæ of Lorenzini and neuromasts. This fact, and the diffuse condition of the buccalis branches seem to indicate that the nerve under discussion is in a primitive condition. The anastomoses, which are so conspicuous in dissecting the branches of the buccalis, indicate the first step from a primal to the secondary condition, such as is found in most Elasmobranchs, where the single buccalis of this species is represented by two or three main branches. There are similar anastomoses in that portion of the external mandibularis VII. where it is at some distance from the neuromasts supplied. The anastomoses in the case both of the buccalis and external mandibularis VII. indicate a secondary simplification of the nerve-supply.

(*c*) The truncus *hyomandibularis* of the Facialis originates from the medulla by two roots at the same level as the roots of V. and VII. It passes at first into the large foramen common to the whole trigemino-facial complex, then bends backward and passes outward through its own foramen. The distal end of the cephalad root, which is probably the external mandibular lateral line root, is connected with the Gasserian ganglion by several small strands—the rami communicantes (Plate LXVIII. fig. 2, R.C.): posteriorly, the complex hyomandibular ganglion is connected with the auditory nerve by the pars intermedia (fig. 2, P.I.). General cutaneous fibres enter the hyomandibular ganglion from the Gasserian ganglion by the rami communicantes. About 5 mm. from the brain, just as they emerge from the chondrocranium, the hyomandibular roots unite and swell into a large ganglion, bilobed at its distal extremity. The cephalad portion—the geniculate ganglion—gives rise to the pre- and post-trematic VII. rami (fig. 1, Pr.F. & Pt.F.). The caudad portion, which is the smaller, is the external mandibular ganglion—that is, the most caudad lateralis ganglion of the Facialis. This ganglion gives rise to the truncus hyomandibularis, which contains the lateralis components which separate out as the rami externi mandibulares, as well as some components of a branchiomeric nerve.

There may be, in a form as low as *Chlamydoselachus*, general cutaneous fibres belonging properly to the Facialis root, as well as

those belonging to the Trigeminal; but, even there, a large cutaneous component could not be expected, for Johnston writes (**15**. p. 185): "That even in *Petromyzon* the dorsal and lateral portions of this area" (the cutaneous region of the hyoid segments in non-operculate forms) "are being encroached upon by the branches of the Trigeminus."

After a course of about 4 cm. the truncus hyomandibularis divides into three branches, which vary slightly on the two sides. The most cephalad, the r. externus mandibularis A (fig. 1, E.M. VII. A) passes forwards to supply that closed portion of the hyomandibular canal (H.L.) which lies above the mouth, and which is the nucleus of the whole complicated hyomandibular canal of *Chlamydoselachus*. This branch innervates neuromasts only. The second branch (E.M. VII. B) passes downwards and forwards to supply the open lateral-line canal (H.L.A.) which lies along the side of the lower jaw. The nerve is continued beyond the canal to break up into a number of small branches, part of which supply a very small group of ampullæ (H.A.), the remainder being distributed to the skin. Two fine twigs (E.M. VII. D & E) are given off on the caudad side near the origin of this branch. The first (E.M. VII. D) curves upwards to supply the dorsal extension (L to M) of the hyomandibular canal; the second (E.M. VII. E) passes caudad to supply a few neuromasts in the first part of the hyomandibular canal B (J to H). These two twigs are not constant in their origin. Another branch of the t. hyomandibularis, the largest and most caudad (E.M. VII. C), passes downward and then cephalad to supply the large open lateral line canal (H.L. B) which lies towards the middle line of the lower jaw. During the first part of its course this branch lies at some distance from the canal, to which it sends numerous fine nerves. The latter anastomose frequently, recalling the condition of the long fine branches of the r. buccalis. It supplies neuromasts principally, but also sends a number of fine twigs to the skin (C.F.). Johnston finds that in *Petromyzon* (**15**) "The hyomandibularis certainly innervates the ventral cutaneous area of this segment." He further adds in the same paper: "It is to be expected that the same will be found in other Cyclostomes and in Selachians, and it is not surprising to find in a ganoid (*Amia*) this component persisting in the VIIth root." It still remains to be found whether the sense-organs supplied are general cutaneous or communis, and whether, if they are the former—which is probable,—that component is present in the facialis root itself or derived from the trigeminal. The former seems more likely, as there is no anatomical reason why the trigeminal cutaneous components should pass to the lower jaw by the truncus hyomandibularis when they could more easily pass directly by the ramus mandibularis V., which is typically both motor and sensory (general cutaneous). About halfway between its origin and termination r. externus mandibularis C gives off ventrally a nerve nearly as large as itself (H + M), which after a course of 4 cm.

divides into two rami. One of these (R. H.) passes to the intermandibular muscles. It was not possible to determine satisfactorily if any cutaneous fibres were present. This nerve is the ramus hyoideus. The second ramus passes inwards and forwards to be distributed to the floor of the mouth, in front of and at the sides of the tongue; presumably this consists of communis fibres, and is therefore the r. internus mandibularis.

Two nerves originate side by side from the *geniculate* ganglion, the cephalad being about twice the size of the caudad. The former is the r. pre-trematicus facialis; the latter the remnant of the r. post-trematicus facialis.

(*d*) The r. *post-trematicus* VII. (Pt.F.) passes somewhat backward, and at a distance of 5 mm. from its origin sends a fine branch posteriorly to be distributed to the top of the spiracle. At a further distance of 5 mm. three branches originate—two of these pass along the top and to the caudad side of the spiracle, whilst the third passes inwards and anteriorly to supply tissues of the upper jaw. The remainder of this r. post-trematicus then bends suddenly cephalad to unite with the r. pre-trematic VII. This ramus probably represents the original position of the complete r. post-trematicus VII., part of whose fibres are now united with lateralis elements to make up the t. hyomandibularis. The small size of this ramus is due to the disappearance of the spiracular gill and the reduction of the spiracle, which, in this species, is merely a pouch opening into the hyobranchial cleft. Like other degenerating nerves, it has a tendency to coalesce with neighbouring nerves: thus, here it joins the r. pre-trematicus, whilst in other cases it has coalesced with the r. mandibularis V. (**13.** p. 413). In a second specimen the post-trematicus divided into seven fine branches which had no connection with the pre-trematic ramus.

(*e*) The r. *pre-trematicus* VII. passes cephalad and downward, giving off three fine branches (fig. 1) which can be traced for only 1 cm. towards the snout into the connective tissues. After the union of pre- and post-trematic rami the two palatine branches (fig. 1, P.) are given off, and then the nerve continues its course as the chorda tympani (Pr.F. (ch.)).

(*f*) The rami *palatini* VII. pass cephalad on to the mucosa of the mouth, running parallel to one another, the one near the median line, the other more laterad.

(*g*) The *chorda tympani*, which is a direct continuation of the r. pre-trematicus, passes caudad and ventrad, immediately under the mucosa of the anterior wall of the first gill-cleft—that is, it passes along the upper jaw between the latter and the hyoid arch. The chorda was traced on to the ventral part of the mouth. On the way it gave off branches to the hyoid mucosa and a few to accompany the cartilages of the mandibular arch. This nerve fulfils every requisite for the chorda as determined by Cole (**3.** p. 657 on), viz.:—(1) in arising from the base of the r. palatinus; (2) in entering into branchial relations with the mandibular arch; (3) in consisting of special sensory fibres; (4) in

having a representative of the lingual branch—*i. e.*, the nerve is continued ventrally on to the pharynx. It should be pointed out, as Herrick justly says (**13.** p. 324), that as both pre- and post-trematic nerves must originate from the base of the geniculate ganglion, this point of origin cannot be considered a diagnostic feature for the chorda. The remaining conditions, however, are sufficient to determine the chorda, and agree also with the characters required by Herrick (**13.** p. 321).

Allis (**1.** p. 182 *seq.*) has discussed the subject generally, and comes to the conclusion that it is still uncertain whether the chorda is pre- or post-trematic, and that the whole chorda literature is in a nebulous condition. With our present knowledge Allis's conclusion cannot be considered justifiable, and for the most reliable conclusions we may still read Herrick (**13.** p. 316 *seq.*).

F. The Glossopharyngeus.

The *Ninth* Nerve arises from the medulla by two roots. These roots, of which the cephalad is the smaller, arise in the same vertical plane, but on a lower level than the first large root of the Vagus. This first vagal root is the principal lateralis root, so that here, as "in all cartilaginous fish," the ninth nerve "arises from the medulla . . . . under cover of the anterior rootlets of the lateralis" (**3.** p. 664). These relative positions are important, because they probably indicate that in origin the lateralis fibres arise from a segment or segments anterior to that to which the fibres of the ninth nerve belong. The cephalad root is motor, the caudad is sensory. The latter contains a strand of large medullated fibres on its cephalad side, which strand consists without doubt of the lateralis component which passes into the dorsal branch to be described later.

The roots, which soon unite, pass through the chondrocranium by a special foramen. At a distance of 1·5 cm. from the origin, and outside the chondrocranium, the nerve swells into a large ganglion. About halfway between the exit from the brain and this ganglion there appears on the nerve a somewhat elongated but obvious swelling, from the distal end of which is given off a branch which passes dorsally and somewhat inwards through the cartilage of the cranium. Shortly after entering the cartilage this dorsal branch gives off a fine twig, which passes caudad, but which unfortunately was not traceable in any case to its destination. The main dorsal branch then passes somewhat cephalad, and near the surface of the chondrocranium divides into two fine branches. One of these apparently led to a neuromast, but serial sections would be necessary to definitely demonstrate this. The other branch proceeded to the succeeding neuromast. Transverse sections were made of the dorsal branch of the Glossopharyngeus, and, for comparison, also of the dorsal branch of the Vagus. Both branches were found to consist chiefly of large medullated fibres

of the same diameter, which stained in the same way. As it is certain that the dorsal branch of the Vagus supplies neuromasts, these large fibres are no doubt lateralis fibres in the dorsal branches of both the Glossopharyngeus and Vagus. On histological grounds, therefore, the innervation of neuromasts by a dorsal branch of the Glossopharyngeus may be considered certain. Both dorsal branches, especially that of the Vagus, contained smaller medullated fibres, probably general cutaneous. The next following neuromast was supplied by the lateralis vagi. The position of these two neuromasts, which are supplied by this dorsal branch of the ninth nerve, are in approximately the same position as those innervated by the ninth nerve in some Siluroids. It should be noticed that in *Amia* the dorsal branch of the ninth nerve had a separate root and ganglion, and that this dorsal branch must be regarded as a part of the lateral-line system (**3**. p. 666). The portion of the nerve which it was not possible to trace probably supplied the dorsal cutaneous area, and partly represented the general cutaneous elements of a dorsal ramus. Cole (**3**. p. 664), speaking of the condition in *Chimæra*, gives no explanation of this dorsal branch, but merely says: "a dorsal branch . . . . passes straight up to the skin of the occipital region." In species in which there is no lateralis dorsal branch of the ninth nerve, these neuromasts are doubtless innervated by the r. lateralis vagi. A similar dorsal branch of the Glossopharyngeus is described by Ewart and Cole (**6**. p. 476) for *Lœmargus*, which divided into two branches, one supplying neuromasts (three), and the caudad, which was not traced in *Chlamydoselachus*, supplying "fibrous tissue between the muscles and the cranium."

From the inner side of the glossopharyngeal ganglion a fine nerve passes outwards above the space between the hyoid and the first branchial arches, and next bends suddenly downwards and inwards towards the roof of the mouth. It there divides into three branches, which pass forward along the roof of the pharynx, parallel and equal. In this group of branches we find the equivalent of the single visceral branch of other species.

The *pre-trematic* IX. passes along the inner side of the hyoid arch, contiguous with the efferent branchial blood-vessel. About 6 cm. from its origin the nerve divides into a number of small branches which appear to be distributed throughout the arch. These branches cannot be followed to their terminations, but are probably wholly sensory.

The *post-trematic* IX. is larger than the pre-trematic. It passes along the inner edge of the first branchial arch, sending many small branches into the filaments and two branches over the cerato-branchial cartilage at the outer angle of the arch. The main portion of the nerve terminates ventrally on the pharynx in a number of fine branches.

On the right side of one specimen the glossopharyngeal ganglion and a small portion of the post-trematic IX. were bound by connective-tissue to the Vagus. The glossopharyngeal ganglion

was so closely united with the Vagus that it required very careful dissection for separation.

G. The Vagus.

The *Vagus* arises by from nine to twelve roots from the hinder end of the medulla. The lateralis root, which is the most cephalad, is invariably large, the remainder are small. These small roots are not symmetrical in number and arrangement even in the same fish, much less do they agree in different fishes. The roots arise at the same level, being arranged in an arc which extends from the side of the medulla to the beginning of the spinal cord. The large lateralis root in one specimen originated 5 mm. in front of the small roots. In another specimen, however, all the roots formed a continuous group. These results both agree with and differ from those of Garman, who states (**7**. pp. 17 & 18): "The tenth pair (Vagus) is somewhat asymmetrical, having eight roots on one side and twelve on the other. There are also four pairs of ventral roots near the median line." There were no traces of any median ventral roots uniting with the vagal complex, but there have been so many differences in the specimens dissected that too much weight must not be attributed to them. On general grounds, however, it would be indeed interesting to find any median roots going to the Vagus, for although the Vagus is now regarded as a complex of ventral roots, those ventral roots are regarded as consisting of only visceral sensory and motor components. The only nerves which arise in the median position are the third and sixth—that is, two pairs of purely somatic motor nerves. These nerves come from the somatic motor tract, which lies median and ventral. Any other nerves originating in the same region would presumably also be somatic. If Garman were right, his specimen suggests the retention of the somatic motor component of the Vagus, whereas, in all cases, so far as is known, the remains of that component has passed into the hypoglossal (**14**. p. 224 *seq.*). This would indeed be a primitive condition.

The group of vagal roots passes outwards and somewhat caudad towards the vagal foramen, the separate roots uniting just before they enter the cranial wall. This composite nerve swells into a large and apparently indivisible ganglion, which lies half in and half outside the cartilaginous wall. Immediately after the union of the vagal roots, two dorsal branches (A and B) are given off. Branch A passes up through the cartilaginous wall and divides therein. The more anterior part supplies the neuromasts of the second transverse commissural canal. This is a highly variable nerve, as the neuromasts supplied differed in number from one to five even in the two specimens examined. The other and finer branches of A supply the last inch of the closed canal, *i. e.* the region between the neuromasts supplied by the Glossopharyngeus and the beginning of the open canal of the trunk. In this region the number of neuromasts supplied varied from five to eleven.

The small dorsal branches of the Vagus run very near to the dorsal branch of the ninth and it is possible that one might be mistaken for the other. Branch B passes dorsad and soon divides into a number of smaller branches which supply approximately the first 2 cm. of the open body-canal.

The posterior two-thirds of the vagal ganglion can with difficulty be partly dissected. On the inner side it consists mainly of a large portion apparently indivisible, which gives rise to the lateral line nerve and is therefore the representative of the lateral line ganglion. On the outer side it consists of the basal portions of four nerves, which in a side view hide the lateral line ganglion.

The first third of the vagal ganglion is indivisible, and presumably contains the ganglion-cells of the intestinal branch and of those branchial branches which, so far as can be seen by dissection, have no separate ganglia.

In one specimen, branches A and B arose directly from the vagal ganglion instead of between the origin of the nerve and the ganglion. Here branch B passed dorsad and then caudad for about 4 cm., giving off a number of branches which supplied between 20 and 25 neuromasts, which were situated at irregular intervals, in places being only 2 mm. apart. The first 4 cm. of the Vagus is spirally arranged within the nerve-sheath. This allows for the considerable stretching that occurs with movements of the branchial "frills."

From the lateral line ganglion there pass two equal lateral line nerves which unite into a single strand for a distance of 1 to 2 cm. These strands anastomose irregularly. The more dorsal nerve in one case gave off 8 fine branches to the neuromasts. In another specimen it gave off no branches.

(*a*) The *lateral line* nerve, a wide riband-like strand, passes caudad and somewhat ventrally, giving off dorsally numerous very fine nerves to the neuromasts. After a course of about 5 or 6 cm., the nerve disappears between the longitudinal dorsal muscles and passes alongside the vertebral column about 3 cm. from the surface of the body. At intervals along the body, the main nerve is separated into two strands which reunite at distances varying from 1 to 2 cm. Fine dorsal branches are given off at intervals equal to about one and a half myotomes. The branches supply from about 5 to 9 neuromasts each. They may divide either immediately after leaving the main nerve or not until near the final distribution. They have a long course (4 to 6 cm.), difficult to dissect, each describing approximately a semicircle. In *Chlamydoselachus*, as in the common Dogfish, the lateralis nerve is situated deeply, but in the former more deeply than in the latter. This is curious and difficult to explain, as the lateralis system in this species is primitive relatively to that of a Dogfish.

(*b*) *Vagus* 1. The first branchial division of the Vagus can be dissected out from the ganglionic mass to a point as far forwards as the first third of the ganglion. At this point the nerve has a flattened ganglionic swelling. Immediately above the second cleft

the nerve divides into the pre-trematic and post-trematic branches, of which the latter is three times the larger.

The *pre-trematic* branch runs along the caudad side of the cartilaginous rays as a single nerve, until an inch beyond the angle of the arch, when it divides. Many minute branches are sent off by the main nerve into the branchial filaments. Near its origin the pre-trematic gives off the *visceralis*, which passes immediately inwards under the epi-branchial cartilage of the first branchial arch, where it divides into two branches. One of these runs caudad, the other cephalad, above the mucosa of the roof of the mouth.

The *post-trematic* divides into two branches 1 cm. from its origin; of these the smaller (B) passes along the anterior base of the branchial filaments of the second branchial arch, the posterior (A) and larger branch also runs along the base of the filaments, but more laterad than the smaller branch. Branch A sends side-branches up into the cartilaginous branchial rays and to the muscles thereof, as well as some branches which pass between the rays, apparently to the pre-trematic filaments of the succeeding cleft. Branch A chiefly supplies the muscles and rays, whilst branch B supplies filaments.

(*c*) *Vagus* 2 also begins in the ganglionic mass with a flattened ganglion. The nerve then passes obliquely backwards for about 4 cm. before it divides into the pre- and post-trematic branches over the third branchial cleft. The pre-trematic is only half the size of the post-trematic. It runs as a main nerve to the end of the arch, and many small branches are sent from it into the filaments. Less than 5 mm. from its origin it gives rise to the small *ramus visceralis*. This branch passes backward and inward over the top of the cleft and under the epi-branchial cartilage, where it suddenly turns forward to be distributed to the mucosa of the dorsal wall of the pharynx. In a second specimen, the visceralis arose directly from Vagus 2. On the other side of the same specimen there was a transverse connecting-branch between the pre-trematic and the visceralis.

The *post-trematic* runs immediately under the mucosa of the cleft at the base of the rays. It divides into two branches about 1 cm. from its origin. The larger branch (A) runs along the arch about 5 mm. from and parallel to the smaller branch (B). These two divisions continue their course nearly to the end of the arch, the distribution of the smaller branches being as in Vagus 1. Branch B of Vagus 2 is in proportion smaller than branch B of Vagus 1. This point should be noticed.

(*d*) *Vagus* 3 can be dissected as a separate nerve, as far into the vagal ganglion as Vagus 1 and 2. Here, however, there is no external trace of the ganglion, but, when the end of the nerve was teased out, a few ganglion-cells were found. The nerve passes backwards and somewhat ventrally for 4·5 cm. before it divides into a very small pre-trematic and a large post-trematic. The pre-trematic, which is very small, has the usual course. As with

Vagus 2, it sends off a visceral branch which has the same course and distribution as the other visceral branches already described. The post-trematic divides into two parts (A and B) of almost equal size, which run parallel to one another as in Vagus 2. The fine side branches which are so numerous in the equivalent nerve of Vagus 2 cannot be traced here. It is probable that branch A has approximately the same function as the branches which Cole calls "accessory skeletal" in *Chimæra* (**3**. p. 667 &c.).

(*e*) *Vagus* 4, 5, 6 and the truncus intestinalis are so closely united that they cannot be separated for a distance of 2 cm. from the vagal ganglion. There is no external trace of separate ganglia, or of a separate compound ganglion for these four nerves. At a distance of 2 cm. from the vagal ganglion, Vagus 4 can be dissected away. This nerve passes obliquely backward to divide just above the fifth branchial cleft into a very fine pre-trematic and a stout post-trematic. The pre-trematic could be traced only for 15 mm., that is about 1 cm. after it gives off the visceral branch. The post-trematic soon divides into two equal branches which run parallel. There is nothing special about the course of the branches in this segment. The tendency toward a reduction of the pre-trematic is carried further here than in the more cephalic segments. Further, it is noticeable that the pre-trematic of Vagus 4 lies in close association with the two divisions of the post-trematic of Vagus 3. From this association and the reduced size of the pre-trematic branches, it may be deduced that the pre-trematics are being replaced by the post-trematics of the immediately preceding segment. Ultimately such a tendency would lead to the condition found in some Teleosts. As the pre-trematic and post-trematic filaments appear to be equally well developed, the reduction of the pre-trematic nerves can only be accounted for on the supposition that some other nerves are replacing them functionally.

(*f*) *Vagus* 5 can be dissected from the combined branchial and intestinal nerve about 1·5 cm. beyond the point of separation of Vagus 4. It then passes obliquely downward for about 3 cm. before it divides into the pre- and post-trematics. In one case Vagus 5 divided into the pre- and post-trematic near the branchio-intestinal riband. The two divisions are of unequal size, the pre-trematic being the smaller in two out of three nerves dissected. The large size of the post-trematic is remarkable, as there are *no* filaments upon the posterior wall of the sixth cleft, *i. e.* upon the sixth branchial arch.

The *pre-trematic* passes along the fifth branchial arch immediately under the lining membrane, along the base of the cartilaginous branchial rays. These rays separate this nerve from the two parts of the post-trematic of Vagus 4. Pre-trematic 5 sends small branches outwards among the branchial filaments. On one side, where the forking of Vagus 5 took place at an unusual distance from the cleft, a fine branch united the pre- and post-trematics about 5 mm. from the fork. The *visceralis* is given off

from the pre-trematic in the usual manner. The post-trematic passes along the sixth arch, sending out no branches, but unites, halfway along the arch, with a fine nerve (Pl. LXVIII. fig. 1, V. 6), probably Vagus 6. This combined nerve (fig. 1, V. 5 + V. 6) could be traced along the arch as far as the middle of the cerato-branchial cartilage, where it divides into a number of small branches which supply the arch and muscles attached to it. No fibres have been traced on to the vestigial seventh arch. On one side, not only do post-trematic 5 and Vagus 6 unite completely, but they are also connected by a transverse branch (fig. 1, Con. V. 5).

(*g*) When the nerve called *Vagus* 6 is traced upward, it is found to originate from the vagal riband, between the origin of Vagus 5 and the point where the intestinal trunk divides. Traced from its central connections Vagus 6 passes obliquely downward and caudad, to fork over the anterior cardinal. The anterior part unites with the post-trematic of Vagus 5 and the posterior with one of the first spinal nerves. The origin, course, and distribution of this nerve strongly suggests that it is the remnant of the sixth branchial nerve to the degenerate seventh branchial arch. It is highly probable that serial sections would show that the combined nerve sends branches not only to the sixth arch but also to the vestigial seventh arch, which lies in close proximity to the former. The posterior division of Vagus 6 is very small and unites with a spinal nerve (or nerves), whose main distribution is to the median mandibular muscles.

The anterior cardinal vein in *Chlamydoselachus* lies in the position of the vanished seventh cleft, but in most Elasmobranchs in the position of the missing sixth cleft. In the latter, the vein sometimes lies in the notch, so common on the fifth branchial arch, which in many cases is undoubtedly produced by a remnant of the sixth arch coalescing with the fifth. Probably as an arch and its cleft disappeared the anterior cardinal vein was pressed forward and took up the position of the missing cleft. According to this reasoning, Vagus 6 may be said to theoretically fork above the seventh cleft.

In the formalin specimen, which was a mature female, no trace of the seventh arch was found and Vagus 6 was in a much reduced condition. Vagus 5 divided above the sixth cleft into pre- and post-trematics, which were of almost equal size. The pre-trematic 5 had the usual course. The post-trematic passed along the anterior side of the sixth arch for a short distance, then divided into two branches, a small anterior and a larger posterior. The former continued to course along the anterior side of the sixth arch and must be regarded as the true post-trematic of Vagus 5, whilst the latter passed along the posterior side of the last arch to be distributed chiefly to muscles attached to the unusually enlarged end of the cerato-branchial cartilage. This innervation coincides with that of the nerve described as Vagus 6 in the other specimen. Hence this branch is to be regarded as the remnant of Vagus 6.

(*h*) The remaining riband of the Vagus is the *ramus intestinalis*. After passing backwards for about 1·5 cm. it divides into three main branches (A, B, C), which are distributed to the heart and viscera. The most dorsal of the branches (C) soon divides into two, which, after a sinuous course around the first spinal nerves, pass on to the stomach. Of these two nerves the ventral again divides into two, one passing caudad on to the stomach, the other forward to the heart. The intestinal nerves soon break up into a fine plexus, immediately under the peritoneum. This plexus can only be traced a short distance.

At the present time there is a general tendency to regard the Vagus as a composite nerve, the component parts being a nerve or part of a nerve for each branchial arch and cleft and one or more nerves or parts of nerves to the intestines. Therefore in a primitive Vagus there would be found a series of ganglionated nerves, each equivalent to the Glossopharyngeus, plus the ramus intestinalis, which is probably "the collector of all branchial nerves which may at one time have existed behind the present gill-region" (**14**. p. 228). The dorsal rami of the collected nerves probably disappeared early, owing to the reduction of the dorsal area. The primitive Vagus of this series of primitive branchial and intestinal nerves perhaps alone retained its dorsal ramus to supply the reduced cutaneous areas of its own and the immediately following segments. The most primitive Vagus yet found is in *Chimæra*. In *Chlamydoselachus* also one would have expected to find the Vagus not one nerve but a series of nerves. This expectation is, however, by no means fulfilled, as appears by the foregoing description. The condition here is intermediate between that of *Chimæra* and *Scyllium*. In *Chlamydoselachus* there is a series of roots which have the appearance of being somewhat pulled forward in order to emerge somewhat anteriorly to their region of origin. This direction in which the roots pass, no doubt indicates a comparatively recent union of these roots into one nerve. In higher forms we find the vagal complex passing backwards out of the cranium, whilst the comparatively new spinal accessory roots are first pulled forward before they can pass backwards and out of the cranium. How the condition in *Chlamydoselachus* may have arisen from a simple *Chimæra*-like condition is best expressed in Johnston's words (**14**. p. 226):—"It appears that the visceral sensory and motor fibres of the caudal branchial segments, instead of continuing to reach the brain by way of the dorsal roots proper to their segments, have progressively changed their course so as to run to the brain through the root of the next more cephalic segment. This process may have begun as a result of the expansion of the gill-sacs and growth of branchial arch muscles which served to crowd the ventral rami of the nerves at the caudad end of the gill-region. When the shifting had brought the penultimate gill back to the level of the ultimate nerve root, the fibres of the ultimate ventral rami shifted their course to the root of the penultimate nerve. . . . . As the process

went on progressively the branchial and pharyngeal rami became united by the common branchio-intestinal trunk which enters the brain by way of the Vagus root" (**14.** p. 229). "The motor roots must have been collected under the influence of the sensory components. . . . . As the motor fibres grow out from their nuclei in the brain they must follow some path of low resistance in travelling to their muscles. Since the motor fibres develop late, they find such a path already provided in the near-by sensory root. The motor fibres follow this and a mixed trunk is formed. When the sensory fibres of a given root shift their course . . . . to the root next cephalad, the motor fibres on issuing from the brain find no path in that segment, but must turn forwards to the next cephalic sensory root and follow it. As this goes on gradually from segment to segment there are formed a number of roots emerging from the cord or brain caudad to the complex and running alongside the brain to join it."

The Lateralis root of the Vagus originates, as is to be expected, from a segment anterior to the vagal roots proper. It has an extra-cerebral course backwards for a considerable distance before it joins the branchio-intestinal Vagus. This indicates a comparatively primitive condition, for, as specialisation proceeds, the root would run intra-cerebrally until nearer the origin of the Vagus proper. The loose union of the constituent nerve-strands of the composite Vagus, added to the presence of at least two separate branchial ganglia, show also that the condition, although not primitive, is not highly specialised.

H. The Spinal Nerves.

Following the Vagus there are four of the so-called spino-occipital nerves, which pass out of the cranium by four separate foramina. Two of these roots in *Chlamydoselachus*, are placed completely under, the third partly under, the cover of the vagal roots. This origin is not to be explained, Johnston thinks, as due to "a shifting through the long branchial region," and a consequent crowding in the vagal region. He says (**14.** p. 231): "The dorsal and ventral hypoglossal roots need not be considered as *spinalartige* nerves. They probably are not equivalent to spinal nerves at all, but are only the general cutaneous and somatic motor components of nerves of the vagus region, the visceral and motor components of which have been collected into the single large vagus root. The presence of these nerves in the vagus region, then, does not require the hypothesis that they have shifted forward from the postbranchial region, but is directly opposed to such an hypothesis." If this view, founded upon the study of nerve components, be true, it will to some extent be in opposition to the conclusions of Fürbringer on the metamerism of the head, for his argument is entirely dependent upon the spinal character of such incomplete nerves as the above.

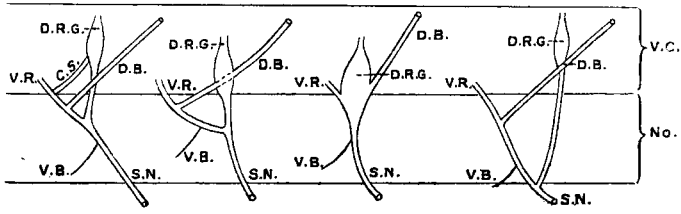
The third and fourth spino-occipital nerves have each a dorsal

branch, which, like the dorsal branches of the succeeding spinal nerves, passes upwards and backwards. No dorsal branches were found on the first two spino-occipital roots. In *Læmargus* there are three spino-occipital nerves, of which the first two had no dorsal roots (**6**. p. 480). Immediately outside the cranium the nerves unite into a flattened strand, the hypoglossal nerve.

The ventral root of the first true or complete spinal nerve originates between the first and second vertebræ. Spinal nerves 1, 2, 3, 4, 5 (Pl. LXVIII. fig. 1) unite with the spino-occipital nerves into a strand, which passes backwards, then outwards towards the pectoral girdle. Spinal nerves 6 and 7 unite with one another before joining this plexus. Spinal nerve 8 runs by its side, but does not actually join. The spinal plexus gives off anteriorly two branches (s.h. 1 and s.h. 2). Branch s.h. 1, which is connected with Vagus 6, passes forwards and downwards to join branch s.h. 2. The resulting compound nerve passes forward near the median ventral line to supply a portion of the median mandibular or hypoglossal musculature. It is probable that this nerve consists only of fibres from the spino-occipital nerves, and would therefore be the homologue of the hypoglossal nerve of higher forms.

The brachial plexus consists of the remaining parts of the composite strand, *i. e.*, the first eight complete spinal nerves, of which the last remains distinct. The brachial plexus is here in a simple condition, for it consists of but few nerves, and those are not intimately united. The innervation indicates that the pectoral fins of *Chlamydoselachus* are made up of a smaller number of segments than in many species; a fact which, according to Goodrich (**11**), indicates that the fin here is specialised rather than primitive, for Goodrich states that potentially a fin might extend all along the body, and that it is only in the specialised forms that it is restricted to a few segments, which may not even be homologous in allied species.

Text-fig. 141.



Spinal nerves from anterior, middle, and tail regions of *Chlamydoselachus*.

C.S. Connecting-strands between dorsal and ventral roots.
D.B. Dorsal branch.
D.R.G. Dorsal root with its ganglion.
No. Notochord.
S.N. Spinal nerve.
V.B. Ventral branch.
V.C. Vertebral column.
V.R. Ventral root.

Each spinal nerve arises by two alternate roots, a dorsal and a ventral. The ventral root arises by three rootlets, then, after emerging from the vertebral column, gives off a large dorsal

branch (text-fig. 141, D.B.) before uniting with the dorsal, ganglionated root. In the anterior and middle regions of the vertebral column, this union takes place at a level with the top of the notochord, but in the tail-region at a level with the base of the notochord, immediately to the inner side of the r. lateralis vagi. The ventral branch (V.B.) is given off at varying points (text-fig. 141).

The dorsal branch (D.B.) of the ventral root runs caudad and upwards, passing over the ganglion of the dorsal root (D.R.G.) to be distributed to the muscles of the middle region of the back. A similar root (ventral-dorsal) has been described by Ewart and Cole in *Raia* (**6**. p. 479). No dorsal branch was found for the complete spinal nerve or for the dorsal root, as it is probable that the dorsal branch of the ventral root receives fibres from the dorsal root as it passes over the latter on its backward course. In one segment (text-fig. 141) the dorsal branch of the ventral root could be seen by the naked eye running over the dorsal root-ganglion, from which it could not be separated; in the succeeding segment the dorsal and ventral roots were joined in the region of the sensory ganglion, and the dorsal branch appeared to arise from the ganglion itself. The spinal nerves here recall the condition of *Læmargus* (**6**. p. 480), of *Bdellostoma* (**16**. p. 176), and of *Myxine* *, in that all three have (1) several rootlets for the ventral root, (2) a dorsal branch from the ventral root which unites with the dorsal root-ganglion or with some portion of the dorsal root.

I A. The Brain.

The external features of the brain, having a typical arrangement, need not be described. Two drawings, however, are given (Pl. LXIX. figs. 7 & 8) as those of Garman are not clear. His ventral view is inaccurate, owing to the very badly-preserved condition of his specimen.

Two points only may be noticed: (1) there is a large rhinocœl extending to the end of the olfactory stalk; (2) the dorsal roof of both prosencephalon and rhinocœl is non-nervous. This second point is of considerable interest, as it recalls the condition of *Ammocœtes* and of the Teleosts. The non-nervous roof may be regarded as primitive when compared with that of *Ammocœtes*, but as specialised when compared with that of the Teleosts. That a non-nervous roof should be found amongst the Elasmobranchs is a point of considerable interest, although its significance is as yet undetermined.

I B. Locy's Nerve.

Locy's nerve, which is present in *Chlamydoselachus*, originates near the middle line, somewhat to the ventral side of the fore-brain. It passes outwards, curving upwards along the anterior and upper side of the olfactory stalk to be distributed between

* Mr. Cole kindly showed me some unpublished drawings of the spinal nerves of *Myxine*.

the end of the stalk and the beginning of the olfactory capsule. On reaching this point, the nerve becomes somewhat enlarged by flattening, then breaks up into a number of fine branches which passed towards the olfactory epithelium but could not be traced to their endings.

J. Summary.

1. This paper is the first description of the cranial nerves of *Chlamydoselachus*.

2. The cranial nerves of *Chlamydoselachus* are not in as primitive a condition as would be expected from the low position of the species in the taxonomic series, especially as regards the vagus and the lateralis nerves.

3. The vagus arises by a series of roots, which, however, cannot be assigned to the separate rami.

4. The ganglia of the vagus cannot be separated completely by gross methods.

5. The number of roots by which the lateralis components arise confirms the suggestion that, in origin, the acoustico-lateralis components belonged to a series of segments.

6. The connections between the acoustico-lateralis elements of V., VII., and VIII. show a tendency towards unification of the system.

7. The glossopharyngeus includes a lateralis component.

8. The r. lateralis vagi unites closely with the true Vagus in the ganglionic region.

9. Locy's nerve is large and well-defined.

10. The roof of the prosencephalon and of the olfactory stalk was non-nervous in the immature specimen examined.

11. There is a direct nervous connection between the r. profundus and the oculo-motor nerve.

12. The profundus nerve here appears as a ramus of the trigeminal nerve.

13. The trigemino-facial complex is less primitive than that of *Chimæra*, but more so than that of most Elasmobranchs.

14. The facialis is in an unusually primitive condition, in that it has a remnant of the post-trematic ramus quite separate from the t. hyomandibularis.

15. With our present knowledge, we are justified in stating that a chorda tympani is present.

16. There is a sixth r. branchialis vagi which passes towards the remnants of the seventh arch.

17. There is a tendency towards a reduction of the rami pre-branchialis vagi, thus leading to a condition found in some Teleosts.

18. There is a hypoglossal nerve.

19. The spiracle is small and opens into the hyo-branchial cleft.

20. The ampullæ of Lorenzini are arranged diffusely. There is no hyomandibular group, but there is a posterior buccal group. The ampullæ have a simple structure.

21. Some of the lateral line canals, such as the main lateral canal and parts of the hyomandibular, vary greatly in individuals and on the two sides of the same individual. There are traces of canals which may be incipient or degenerate. The canal-system is in an unstable condition.

22. The lower jaw has been swung back into a reptilian-like position with the results, (*a*) that to it may be due the absence of the typical maxillo-mandibular trunk; (*b*) that possibly the push-back of the branches of the vagus may have resulted in their unexpected union with one another and with the r. lateralis vagi; (*c*) the great development of a hypoglossal musculature and the presence of a hypoglossal nerve.

23. The internal rectus muscle consists of two well-defined parts.

24. The pectoral plexus consists of very few nerves, and thus the pectoral girdle may be regarded as specialised, again suggesting a relationship between *Chlamydoselachus* and the Teleosts.

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L. EXPLANATION OF THE PLATES.

PLATE LXVIII.

Chlamydoselachus anguineus.

Fig. 1. Diagrammatic drawing of the Cranial Nerves and Lateral Line Canals. The colours (supra-orbital grey-green, infra-orbital pink, hyomandibular lavender, and lateralis orange) are the same as those used in a similar drawing by Cole in his paper on *Chimæra*. The open canals are indicated thus, ' ' '

H.+M.—The common trunk of the ramus hyoideus and ramus internus mandibularis VII.
Hy.—Hypophysis.
I. (A, B, C).—The three principal rami intestinales.
I.H.—The cardiac branch of the ramus intestinalis.
I.M.VII.—R. internus mandibularis VII.
I.O.—Inferior oblique muscle.
I.O.L.—Infra-orbital lateral line canal.
L.I.—Lobi inferiores.
Lin. Lat.—Linæ laterales or restiform body.
L.L.—Main lateral line canal.
L.N.—Locy's nerve.
Mxb.—Branch of the maxillaris which becomes united with a branch of the buccalis.
Mxb. b.—Two fine nerves which appear to originate from a branch of the buccalis, but which are composed of general cutaneous fibres which have come from Mxb.
O.S.—Olfactory stalk.
Oc. 1, 2, 3.—First three spino-occipital nerves.
Op. L.—Optic lobes.
Op. S.—Optic stalk or "cartilago-sustentaculum oculi."
P.—Palatine branches of the facialis.
P.B.A.—Postero-buccal ampullæ.
P.I.—Pars intermedia.
Pr. F.—Pre-trematic facialis.
Pr. F. (ch.).—The chorda tympani.
Pr. & Pt.—The pre- and post-trematic rami of IX. and of the vagus.
Pro.—Profundus branch of V.
Pros.—Prosencephalon.
Pt. F.—Post-trematic facialis.
R.V.—Root of nervus trigeminus.
R.C.—Ramus communicans.
R.Ext.A & B.—Two parts of the rectus externus.
R.H.—Ramus hyoideus VII.
R. In.—Rectus internus muscle.
R. Inf.—Rectus inferior muscle.
R. Man. V.—Ramus mandibularis V.
R. Max.—Ramus maxillaris V.
R.O.—Ramus oticus with cutaneous branches R.O.C.
R.S.—Rectus superior muscle.
S. (1, 2, 3, 4, 5, 6, 7, 8).—The first eight spinal nerves.
s. h. (1, 2).—The two branches which make up the hypoglossal nerve.
S.O.—Occipito-spinal riband.
S. Ob.—Superior oblique muscle.
S.O.A.—Supra-orbital ampullæ.
S.O.L.—Supra-orbital lateral line canal.
S. Op. V.—Superficialis ophthalmicus V.
S. Op. VII.—Superficialis ophthalmicus VII.
S.V.—Sacci vasculosi.
T.H.—Truncus hyomandibularis.
V. (1, 2, 3, 4, 5, 6).—The six branchial branches of the vagus.
V. 5 + V. 6.—The nerve produced by union of the post-trematic of vagus V. and part of vagus VI.
V.G.—Visceralis branch of IX.
Vis.—Visceralis branches of the vagus.
III.—Oculo-motor nerve.
IV.—Fourth nerve.
V.—The Gasserian ganglion.
V. + VII.—The united Gasserian and buccalis ganglia.
VII. b.—Ramus buccalis.
VII. h.—Truncus hyomandibularis.
VIII., VIII. A, VIII. B.—The ganglion and the two principal rami of the eighth nerve.
IX., IX. g.—The glossopharyngeal nerve and its ganglion.
X., X. g.—The vagus nerve and its composite ganglion.
X. A & X. B.—Dorsal branches of the vagus to neuromasts.

4. Descriptions of Two Mammals from the Ituri Forest. [With a Supplementary Note on the Buffalo of the Semliki district.] By R. LYDEKKER.

[Received November 13, 1906.]

(Plate LXX.*)

From among a collection of mammal skins and skeletons obtained by Major Powell Cotton in the Ituri Forest and submitted to me, at his direction, by Rowland Ward Ltd., two specimens, representing as many species, appear worthy of being brought to the notice of the Society. Before proceeding to their description, I may take the opportunity of mentioning that Major Cotton has generously expressed his intention of presenting to the British Museum the type specimens of any small mammals in his collection which prove to be new, after they have been described.

The first animal for notice is a Cat which I propose to call

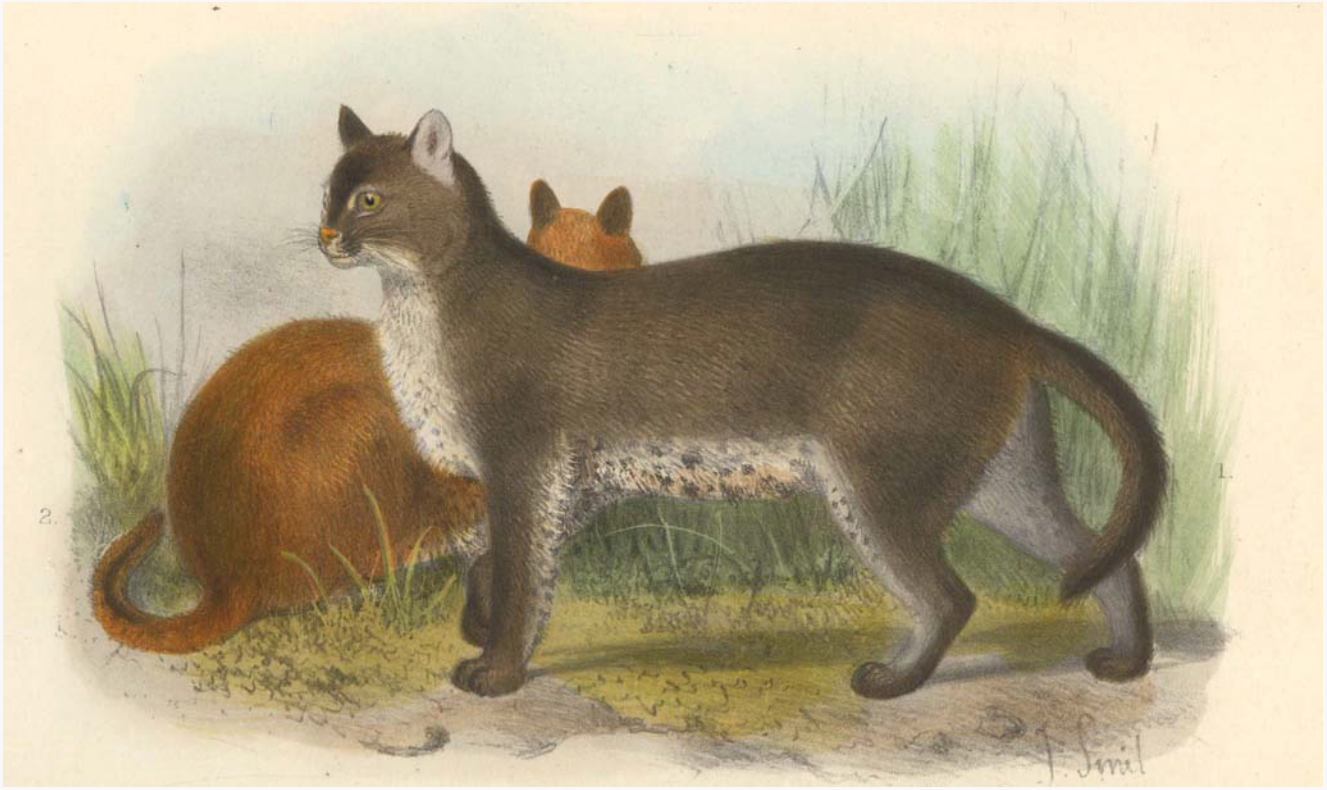
FELIS CHRYSOTHRIX COTTONI, subsp. nov. (Plate LXX. fig. 1.)

West Africa and its "hinterland" are, as Professor Paul Matschie has remarked †, the home of a very imperfectly known group of medium-sized and more or less uniformly-coloured Wild Cats, some of which display a tendency to a rufous and others to a grey phase. In this group are included *Felis chrysothrix*, *F. celidogaster*, and *F. aurata* of Temminck, *F. neglecta* of Gray, *F. rutila* of Waterhouse, and *F. servalina* of Ogilby, or Pucheran. Despite the imperfection of our knowledge of the group (which is poorly represented in the collection of the British Museum), one thing is quite certain, to wit, that these six names do not represent a corresponding number of species, whatever may be the case in the matter of races.

Dr. Matschie (whatever may be his present views on the subject) expressed the opinion in the passage cited that there might be two recognisable forms—one, *F. celidogaster*, inhabiting the northern, and the other, *F. chrysothrix*, the southern districts of Guinea. The same view is adopted by Dr. Trouessart in the first edition of his "Catalogus," who regards *F. neglecta* (from the Gambia) as a synonym of *celidogaster*, and gives the range of the species as extending from the Gambia to Upper Guinea and Sierra Leone. In the second edition, apparently by an inadvertence, *neglecta* is, however, given as a synonym of *chrysothrix*. The range of *F. chrysothrix* (which in the first edition is taken to include *aurata* and *rutila*), on the other hand, is given as Lower Guinea, the Congo, Togo, Uganda, and possibly Angola. Of this species, *servalina*, from Sierra Leone, is regarded as a distinct race.

* For explanation of the Plate, see p. 996.

† S.B. Ges. Naturforsch. Berlin, 1895, p. 196.



J. Smit. del. et lith.

Bale & Danielsson, Ltd. imp.

1. THE DUSKY AFRICAN TIGER-CAT (FELIS CHRYSOTHRIX COTTONI)
2. THE RED AFRICAN TIGER-CAT (F. C. RUTILA.)

Felis chrysothrix, the Red Tiger-Cat or Golden-haired Cat, of which the type (in the Leyden Museum) is figured by Dr. D. G. Elliot in plate xxv. of his 'Monograph of the Felidæ,' is generally described as a medium-sized Cat, with the upper parts reddish brown, passing into bright rufous on the flanks, marked on the sides of the body with black spots; the under parts pure white spotted with black; and the tail reddish brown above and lighter below, without either spots or bars. Although the two face-bars so commonly developed in cats are absent, there is a pair of dark blotches above the eyes.

Waterhouse's *F. rutila*, typified by an imperfect skin from Sierra Leone in the British Museum (Pl. LXX. fig. 2), is wholly bright reddish chestnut above, with indistinct darker spots on the flanks, and white below with large brown spots; the tail being nearly half the length of the body, and reddish brown in colour, having a dark line down the middle of the upper surface, and paler on the sides, with obscure indications of dark rings.

As to *Felis celidogaster*, this appears to have been originally described on the evidence of a specimen, supposed to have come from America, purchased at the sale of Bullock's Museum. It was, however, redescribed by Temminck from a Guinea specimen (in the Leyden Museum, and figured by Dr. Elliot in the plate already cited), now generally accepted as the type.

It is described as measuring 26 inches to the root of the tail, while the tail itself measured 14 inches, or rather more than half the length of the head and body. In colour it is grey above with a reddish tinge, and spotted all over with light brown or chocolate, the spots along the middle line of the back being oblong, but elsewhere circular; below it is white with large brown spots, while the tail is bay-brown, with paler brown rings and a blackish tip. Dark bands occur on the throat and chest and the inner sides of the feet. The ears are black externally.

Gray described his Gambian *F. neglecta* as grey, marked on the head and body with small dark spots becoming larger on the flanks, and white below with large blackish spots; the tail, which is quite half the length of the body, having a dark line on the upper surface, with obscure indications of rings on the paler sides. One is led to wonder how this Cat could have been regarded as specifically distinct from *celidogaster*; although the colour is brownish grey rather than grey.

Although most subsequent writers have regarded *chrysothrix* and *celidogaster* as distinct species, Dr. Elliot suggested that they might more probably be considered respectively as a red and a grey phase of one and the same species. In his plate he figured a third African Cat which he regarded as in some degree intermediate between the two.

Turning to Major Cotton's specimen (Pl. LXX. fig. 1), it is quite clear that it is a member of the *chrysothrix-celidogaster* group, with which it accords in the general type of colouring and in dimensions, the length of the head and body being approximately

27 inches (or, allowing for stretching, possibly rather less), and that of the tail about 13 inches. It is, however, much darker than either of the named forms, and may be regarded as the dusky phase of the group.

Having the black ears, white claws, and fully-spotted light under surface characteristic of the group, this Cat may be described as dark smoky-grey above, darker along the middle line of the back and tail, and darkest of all on the crown of the head, where it approaches black. No distinct evidence of spotting on the dark parts of the body or of barring on those of the face and limbs are observable, but there may be a suspicion of disappearing dark rings on the sides of the tail. The under parts and inner sides of the limbs are dirty white, profusely blotched with black.

In the absence of dark markings on the upper parts the Ituri Cat comes nearest to *chrysothrix*, although lacking the face-markings and the spots on the flanks. On the other hand, in colour it is more like *celidogaster*, although much darker, and without the spots on the body and the rings on the tail.

In my opinion, *rutila*, *chrysothrix*, *celidogaster*, and the Ituri Cat (which, as already mentioned, I propose to name after its discoverer) appear best regarded as forms of a single species, which may be severally characterised as follows:—

1. *F. chrysothrix rutila*. General colour bright chestnut-red, distinctly spotted with reddish brown on the flanks which are much lighter than the back; under parts pure white, with large chocolate-brown spots; tail with a dark brown median line or fainter indications of rings.—Gambia and Cameroons.

2. *F. chrysothrix typica*. General colour reddish brown, becoming distinctly rufous on the flanks, where it is spotted with chocolate; under parts pure white with dark spots; tail uniformly reddish brown above without trace of lateral barring.—Lower Guinea.

3. *F. chrysothrix celidogaster*. General colour of upper parts light grey, or greyish brown, spotted all over with brownish; under parts pure white with chocolate spots; tail darker along median line than elsewhere (*neglecta*) with complete or partial dark rings.—Upper Guinea and (?) Gambia.

4. *F. chrysothrix cottoni*. General colour of upper parts dark smoky grey, darker on the middle line of the back and tail and darkest of all on the crown of the head, no spots; under parts dirty white, spotted or (blotched) with blackish; tail without any distinct barring.—Ituri Forest.

Whether any of the other named forms (inclusive of *neglecta*) are entitled to rank as distinct races, I have not sufficient means of forming a definite opinion.

On the assumption that I am right in regarding the four forms

above-mentioned as races, the name of Red Tiger-Cat or Grey Tiger-Cat will be inappropriate to the species as a whole. I would therefore suggest that it should be called the African Tiger-Cat, and the four races here admitted respectively designated the red, the brown, the grey, and the dusky African Tiger-Cat.

The dark hue of the Ituri race is apparently an adaptation to its habitat, and may possibly tend to confirm the view that the Ituri black Ratel described by myself is a distinct species (or race) rather than an individual melanism.

2. RHYNCHOCYON STUHLMANNI NUDICAUDATA, subsp. nov.

The second animal in the collection worthy of special notice is a *Rhynchocyon*, represented by a skin and skeleton, which comes very close to *Rh. stuhlmanni* of Dr. Matschie* from the country immediately west of the Semliki-Isango valley. The present animal came from the Mawambi district.

Rh. stuhlmanni (of which there is no example in the British Museum) is described as being dark brown mingled with yellowish brown above, with two longitudinal rows of blackish spots, connected by a black stripe on their inner sides, and running from the shoulder to the root of the tail; between the dark markings are light brownish spots, and externally to this black-and-light spotted area on each side are two rows of light spots, of which the outermost is very indistinct. In old examples all the markings become obscure. The claws and a streak along the middle line of the belly are whitish; the flanks are like the back; the abdomen is nearly bare, carrying only a few sparse hairs of an ocherey colour; the legs are rusty brown; the tail is yellowish white; and the ears are rusty red.

It will be observed that nothing is stated as to whether the ears and tail are hairy or naked. Since, however, the species is contrasted with *Rh. petersi* and *Rh. cirnei*, in both of which the basal half of the tail and the roots of the ears are hairy, it would seem highly probable that if such points of difference had occurred in the type of *Rh. stuhlmanni*, they would have been mentioned. Again, it is difficult to understand how an animal in which the ears are completely naked could be described as having rust-coloured ears.

The two points in which Major Cotton's *Rhynchocyon* agrees with *stuhlmanni*, and thereby differs apparently from every other member of the genus, are its generally dark colour and the wholly white tail. On the other hand, it differs from the type of that species by the ears being wholly black, by the presence of a patch of bright rufous hair immediately behind each ear, by the absence of any distinct spotting or striping on the body, except for a few light flecks near the rump, and by the brown claws. It is further probable that the naked ears and tail are also distinctive.

* S.B. Ges. Naturforsch. Berlin, 1893, p. 66, and 'Die Säugethiere Deutsch-Ost-Afrikas,' Berlin, 1895, p. 31.

Provisionally, I propose to regard this Elephant-Shrew merely as a race of Dr. Matschie's species, with the title of *Rh. stuhlmanni nudicaudata*; leaving it open whether it may not really claim specific rank.

In its completely naked tail, and apparently also ears, this Elephant-Shrew is distinct from all other Rhynchocyons, unless it be the typical *stuhlmanni*; the one which comes nearest to it in the former respect being *Rh. chrysopygus*.

[Postscript.]

[Since the foregoing paper was read Major Powell-Cotton has sent home two skins and skulls of the Buffalo of the Semliki Valley, in regard to which I communicated the following note to the 'Field' newspaper of January 5th, 1907 (vol. cix. p. 87 *).

These specimens indicate an animal to a large extent intermediate between the great black buffalo of South Africa and the dwarf red buffalo of the west coast, and thus serve to strengthen the view that these (and all other African) buffaloes are merely races of one and the same species. The general colour of the Semliki buffalo (which is well haired) is tawny, with the tip of the tail black, but the tint gradually darkens towards the shoulders, till it becomes blackish-brown on the neck and head. The tips of the ears are, however, fringed with pencils of tawny hair. In size the animal approaches the Cape buffalo, but the horns, which are thin and much flattened, are, as in all the more northern races, widely separated at their bases. The black tail-tip at once separates the Semliki buffalo from *Bos caffer mathewsi* of the Albert Nyanza district, in which that appendage is white (Proc. Zool. Soc. 1904, ii. p. 163). With regard to the buffalo from Ankole, South Uganda, described by Mr. O. Thomas (Proc. Zool. Soc. 1904, i. p. 464) as *B. caffer radcliffei*, it appears from specimens in the Natural History Museum that the hair of that race is wholly black. Among the numerous buffaloes recently described by Professor P. Matschie (S.B. Ges. Naturforsch. Berlin, July 1906) none came from the Semliki district. The Semliki buffalo is therefore apparently a new race, and it is appropriate that it should be named, after its discoverer, *Bos* [*Bubalus*] *caffer cottoni*. Old individuals, I have recently found, become black.]

EXPLANATION OF PLATE LXX.

Fig. 1. The Dusky African Tiger-Cat, *Felis chrysothrix cottoni*, p. 992.
Fig. 2. The Red African Tiger-Cat, *Felis chrysothrix rutila*, p. 993.

Major Cotton's specimen was obtained from the Ituri Forest, Central Equatorial Africa, in the Mawambi district. Both are drawn about $\frac{1}{7}$ nat. size.

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* In the original note the specimen was stated to be from the Ituri Forest; but this, I am informed by Major Cotton, is incorrect.

5. On the Occurrence of the Bruang in the Tibetan Province. By R. Lydekker.

[Received December 4, 1906.]

(Text-figure 142.)

That the eastern end of the Tibetan area, that is to say the Moupin district of Tibet proper and the western portions of the Chinese provinces of Kansu and Sze-chuan, contain, in addition to their own peculiar mammalian types, a large element of the Indo-Malay fauna, is becoming more and more evident. As examples, may be cited the Monkeys *Macacus arctoides tibetanus* and *M. vestitus*, the Sze-chuan Sambar, *Cervus unicolor dejeani*, and several Gorals and Serows. I have now to add to the list a representative of the Bruang, or Malay Bear (*Ursus malayanus*); a type hitherto not known to range northwards of the Garo Hills, so far at least as I am aware.

At the time when the British Museum acquired from Rowland Ward Ltd. the Serow described by myself in the Society's 'Proceedings' for 1905 * and an example of the Tibetan Takin, that firm had in its possession the skull of a Bear reputed to come from the same district (viz., either Eastern Tibet or the north-western provinces of China). This skull was that of a Bruang, but since I had some doubt whether it was really from the Tibetan area, I gave it no further consideration.

I have since learnt that the skin of the same animal came with the skull; and that the entire specimen was mounted and sold to the Bergen Museum as *Ursus torquatus*. The skin, I am informed, had much longer black hair than the ordinary Malay Bear, with the usual white gorget on the throat.

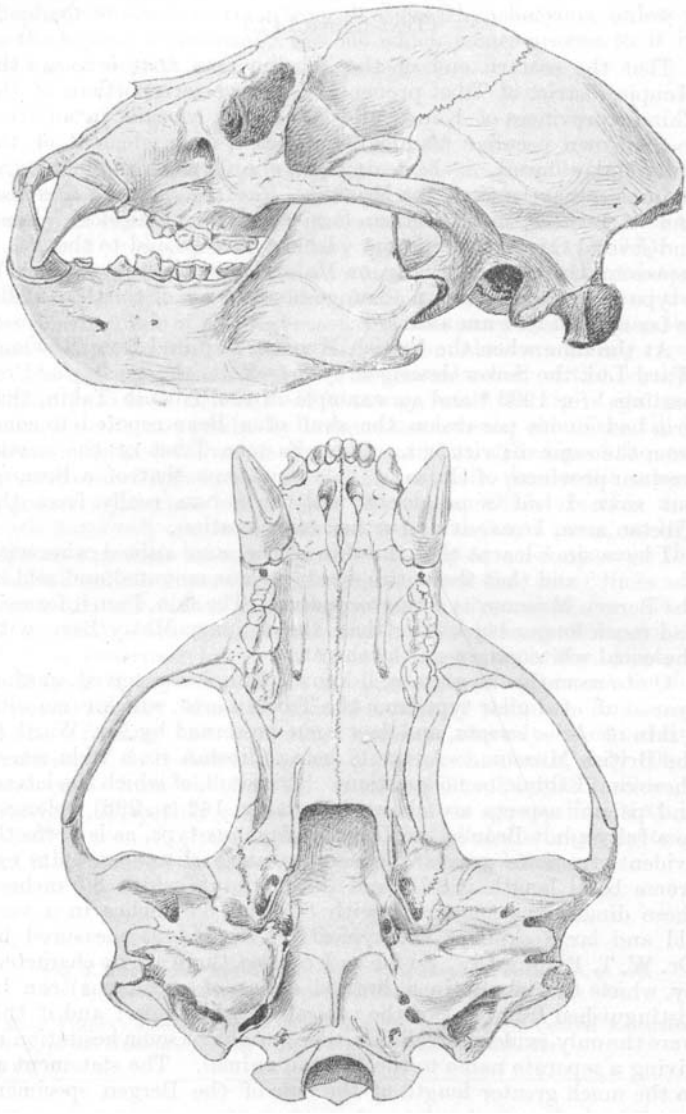
Quite recently the same well-known firm has received another bear-skull of similar type from the Tibetan area, which came with a skin of *Felis scripta*, and has been presented by Mr. Ward to the British Museum. As to its being Tibetan (in a wide sense) there can, I think, be no question. This skull, of which the lateral and palatal aspects are shown in text-fig. 142 (p. 998), belonged to a fully adult Bear of the *Ursus malayanus* type, as is perfectly evident from its great width and relative shortness. Its extreme basal length is 8·75, and its maximum width 8·5 inches; these dimensions comparing with 8·5 and 8·3 inches in a very old and large skull of the typical *U. malayanus* measured by Dr. W. T. Blanford †. So far as I can see, there are no characters by which this skull (in a limited series of specimens) can be distinguished from that of the typical *U. malayanus*; and if this were the only evidence available, there might be some hesitation in giving a separate name to the Tibetan animal. The statement as to the much greater length of the hair of the Bergen specimen,

* Vol. ii. pp. 329 *et seq.*

† 'Fauna of Brit. India—Mamm.' p. 199.

as compared with that of the typical race of the species, seems, however, to justify the racial separation of the Tibetan Bruang,

Text-fig. 142.



Lateral and palatal aspects of the type-skull of the Tibetan Bruang (*Ursus malayanus wardi*). About $\frac{1}{2}$ nat. size.

which may be appropriately named *Ursus malayanus wardi*, the figured skull being taken as the type.

[Since this paper was read I have received from the Director of the Bergen Museum some notes on the Bruang purchased from Rowland Ward Ltd., together with a photograph of the specimen. The skin and hair are wholly black, with the exception of the nose, which is ferruginous, the chin, which is greyish white, and the cream-coloured gorget. Although the head is shorter, the general appearance of the animal seems very like that of *U. torquatus*, the ears being much larger than in *U. malayanus*. In fact, had I not been assured by Rowland Ward Ltd. that both skin and skull came together, I should have thought that a skull of the last-named species had been mounted in a skin of the former. As it is, I hesitate to draw any further conclusions with regard to the distinctness of the Tibetan Bruang from the characters of the skin.]

6. On the Nudibranchs of Southern India and Ceylon, with special reference to the Drawings by Kelaart and the Collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne.—No. II.

By Sir CHARLES ELIOT, K.C.M.G., F.Z.S.

[Received December 11, 1906.]

Subsequently to the publication of my paper on the Nudibranchs of Southern India and Ceylon, which appeared in the Society's 'Proceedings' (Proc. Zool. Soc. 1906, pp. 636–691), the authorities of the Hancock Museum at Newcastle-on-Tyne were fortunate enough to discover a considerable collection of microscopic slides belonging to Alder and Hancock, and most courteously placed the same at my disposal for examination. The objects preserved are almost entirely the buccal organs of nudibranch. from various parts of the world, and I have lost no time in examining such of them as concern the Indian and Cingalese nudibranchs mentioned in my previous paper. It is a pity that it should have been published before the radulæ were discovered, but the results indicated in it are not materially affected, though several of the identifications are confirmed. The present notes should be regarded as a supplement to it. The same abbreviations are used, and references are not repeated except where it seems necessary.

Some of the slides bear full names, but others inscriptions like *Doris* 113, or a simple number. In most cases it is possible to give the name with certainty, for the number refers to the bottle in which the specimen is preserved. Thus *Doris* 113 corresponds to the bottle marked "*No. 113. Doris formosa—Madras, Walter Elliot, Esq.*" No notice has been taken of those

slides which for some reason (generally the disappearance of the labelled specimen) could not be referred with certainty to a specific name, nor of those (e. g. *Madrella*, *Phyllobranchus*, *Kalinga*) which if described would add nothing to already published accounts.

The slides though very neat are not always of the kind most helpful for studying the details of dentition. Often all the teeth are preserved *in situ* and none are isolated, so that it is difficult to distinguish the exact form, and especially to see any denticles which may be present on the innermost or outermost teeth. Several rows at least are commonly in confusion, and hence the formulæ are given as approximate. A wide rhachis is unusually frequent and may in some cases be the result of artificial stretching. The medium in which the radulæ are mounted has in several instances become an opaque gum which impedes investigation, but I have not felt at liberty to remount the objects.

But in spite of these difficulties there can be little doubt of the general character of the radulæ, and the results obtained from their study may be tabulated as follows:—

Hexabranchus marginatus (Q. & G.) = *Doris gloriosa* Kelaart.

Chromodoris gleniei (Kelaart). The reference of this form to the genus *Chromodoris* is confirmed. It is possibly the same as *Chr. cavæ*, and if so the name *gleniei* has priority.

Casella maccarthyi (Kelaart) = *C. cincta* Bgh.

Halgerda apiculata (A. & H.) = *Halgerda punctata* Farran, in all probability.

Doris picta Kelaart is probably a *Platydoris*.

Doris exanthemata Kelaart is perhaps *Asteronotus hemprichi*, and in any case nearly allied to it. But the genitalia are unknown.

Discodoris concinna (A. & H.) = *Disc. concinniformis* Bgh.

Staurodoris rusticata (A. & H.). So far as the external characters and buccal parts can decide the matter, the reference of the form to this genus seems certain.

Thordisa villosa (A. & H.) = *Th. maculigera* Bgh.

Hervia militaris (A. & H.) = *Eolis militaris* A. & H.

Doris spongiosa and *D. tristis* are probably referable to the genus *Trippa*, and the former is perhaps identical with both *T. areolata* and *T. mephitica*. But it is not known if either form has ptyaline glands.

Some details are given of the buccal parts of *Chromodoris zebrina*, *Platydoris formosa*, *Pl. ellioti*, *Pl. striata*, *Discodoris fragilis*, *Disc. pardalis*, *Goniodoris aspersa*, *G. citrina*, *Trevelyana ceylonica*.

In the above statement the first name given is that by which

the animal should be called, so far as our present knowledge goes; but in the following descriptions I have thought it safer to put first the names written on the bottles by Alder and Hancock, which imply no identifications into which an element of theory may possibly enter.

DORIS GLORIOSA Kelaart.

= *Hexabranchus marginatus* Q. & G.

The labial armature and radula confirm this identification. The formula of the radula is about 30 × 60.0.60 as a maximum. The teeth are hamate and rather erect; the outermost smaller but not degraded; the 4–5 innermost markedly smaller than the rest and almost without hooks, as if the tips were broken off.

DORIS GLENIEI Kelaart.

= *Chromodoris gleniei* (Kelaart).

A labial armature and radula are preserved, showing that Alder and Hancock dissected a specimen, though, so far as I know, they have left no record of their investigations.

The labial armature consists of two grey, roughly triangular plates, distinctly separate but almost touching one another. They are composed of bent rods, slightly swollen at the tips.

The yellow radula has a formula of about 60 × 70.0.70. On the rhachis are lozenge-like areas. The teeth are strong and erect and bear at least 6–8 denticles on the outer side. As the teeth are *in situ* and none are isolated, the denticles are nowhere easy to see and become almost invisible in the last 30 teeth, though since they can be seen here and there they are perhaps present on all. The innermost teeth are broad and bear at least one large denticle on the inside and perhaps two or three. The outermost are low, not denticulate on the top, but bearing one jag or denticle at the side.

This radula and labial armature show that *D. gleniei* is a *Chromodoris*, and support the idea that it is closely allied to *Chr. cavæ* Eliot, which may be a variety of it.

CHROMODORIS ZEBRINA.

A. & H. l. c. p. 123.

Alder and Hancock describe the radula as a generic character, but their remarks, confirmed by the slides, show that the description applies to the species *Chr. zebrina*.

The buccal parts as preserved comprise a labial armature and radula. The former consists of two plates, composed of elements arranged in unusually regular rows and apparently mace-like in shape, though none are completely isolated. The outer ones are bifid, but this feature is not so plain in those near the centre of the plates.

The radula is in confusion, but consists of at least 40 rows containing numerous, minute, two-pronged teeth which bear 3–4

denticles beneath the smaller prong. The innermost cannot be seen plainly, but they appear to be lower and broader than the rest, as is usual in this genus, and are probably denticulate on both sides. The outermost teeth also cannot be clearly seen.

Doris maccarthyi Kelaart.

= *Casella maccarthyi* (Kelaart).
C. cincta Bergh.

The buccal parts confirm this identification. The labial armature is composed of hooked rods, bifid in parts but not everywhere. The radula is a close pavement of very minute teeth with a formula of about 250 × 60.0.60. Owing to the teeth being erect it is difficult to see the denticles, but there are at least six on the outer side and probably more. The innermost teeth have also at least 2 (probably 2–4) denticles on the inner side. The outer teeth are smooth.

Doris apiculata A. & H. l. c. p. 123.

= *Halgerda apiculata* (A. & H.).
? = *Halgerda punctata* Farran, l. c. pp. 339–340.

One radula with the note "no collar." The hinder part is in disorder, but there appear to be about 33 rows, which in the midde of the radula contain 45–50 teeth on either side of the rhachis. Those near the centre are more spaced than the rest; they have long bases and low hooks, and the innermost point towards the rhachis. The general effect is that there is a large bare space in the middle of the radula with a few teeth in it. The teeth increase in size outwards up to the middle of the row. The hooks are strongly bent, and the bases rather long, though proportionally not so long as in the teeth near the rhachis. The last 3–4 teeth are degraded and almost spoon-shaped. In a few cases the upper edge of the outermost tooth bears one or two irregular jags.

This animal will probably prove to be identical with the later *Halgerda punctata* of Farran. Both the radula and the external colour agree fairly well. The mantle of *D. apiculata* is said to have borne "elevated conical centres, each of which bears a delicate style or filament," and the plate represents the same character. The preserved specimen of *H. punctata* bore simple tubercles, which were described as papillæ in the living animal. A more definite description is desirable, but it is quite possible that the filaments mentioned by Alder and Hancock are the same as these papillæ.

Doris formosa A. & H.

= *Platydoris formosa* (A. & H.).

Formula of radula about 50 × 120.0.120. The teeth are hamate, moderately slender, and increase in size outwards. The innermost are lower than the rest and cross one another, meeting

over the rhachis. The 2–3 outermost are degraded but not denticulate, though occasionally jagged.

DORIS ELLIOTI A. & H.

=*Platydoris ellioti* (A. & H.).

Radula yellow. Formula about 40 × 100.0.100, but the teeth are considerably deranged. The rhachis is narrow. The innermost teeth are low; the outermost 2–3 are degraded, and the outermost of all sometimes bears a few irregular denticulations. The remaining teeth are hamate, erect, and fairly strong.

DORIS STRIATA Kelaart.

=*Platydoris striata* (Kelaart).

Two radulæ are preserved. One is white, one yellow; both are broken. The formulæ are about 40 × 100.0.100 and 45 × 120.0.120. The teeth are rather slender, not much bent, and increase from the inside. The innermost are not markedly smaller, but are distinguished by their position on the rhachis. The outermost present suggestions of faint irregular denticulation, which, however, cannot be seen anywhere with certainty.

The dentition supports the idea that this species is a variety of *Plat. cruenta* (=*arrogans*) without the red markings; but see my previous paper, p. 647, for the genitalia, and Bergh, Siboga, p. 139, for *Pl. flammulata*.

DORIS PICTA Kelaart.

?=*Platydoris picta* (Kelaart).

A large radula, but hidden by the thick medium in which it is mounted. In consists of about 40 rows containing on each side of a narrow rhachis 100 or more small, thin, crowded hamate teeth. The outermost cannot be seen plainly, but do not appear to be denticulate or much degraded.

This form is probably referable to *Platydoris*, but the genitalia are unknown.

DORIS EXANTHEMATA Kelaart.

?=*Asteronotus hemprichi* Ehrenberg.

One large radula, brownish in front but otherwise white, badly mounted in a gummy fluid. Formula about 35 × 55.0.55, but several rows are imperfect. The teeth are thin, distinctly hamate, and increase consistently up to the end of the rows, where the last 2–3 become degraded but not denticulate. The innermost, and to some extent the second teeth, project into the broad rhachis almost at right angles to the rest.

This dentition is compatible with the view that *D. exanthemata* is *Asteronotus hemprichi*, but Kelaart's energetic language about the ugliness of the animal makes it probable that he had before him if not a distinct species at least a well-marked variety.

DORIS FUNEBRIS Kelaart.

= *Kentrodoris annuligera* Bergh.
= *K. maculosa* (Cuv.).

One radula is preserved, with a formula of about 22 × 25.0.25. The innermost teeth are smaller than the others and much as figured by Bergh.

Label: D. BELLICOSA 32.

Probably = *Discodoris fragilis* (A. & H.).

Two radulæ and labial armatures, labelled as above, seem really to belong to *D. fragilis*, for two specimens from which the radulæ have been extracted are numbered 32 and distinctly marked as *D. fragilis*. Alder and Hancock's remarks (*l. c.* p. 119) suggest that they originally registered the animal as *D. bellicosa*, and then came to the conclusion that it was distinct.

The labial armature consists of two clearly-cut and symmetrical plates, somewhat wing-shaped, and resembling those of *Disc. boholiensis* figured by Bergh (in Semper's Reisen, Heft xvii. pl. dxxxvii. fig. 28). They are yellow and composed of a thatch of straw-like elements, which are sometimes sinuous, especially at the thin ends of the plates.

The two radulæ consist of about 30 and 40 rows respectively, and the smaller contains about 55 teeth on either side of the rhachis. The larger is obscured by the medium in which it is mounted. The teeth are hamate, rather erect, and moderately stout; they increase up to the middle of the half row. The last 4–5 are lower, but not degraded or denticulate. The innermost teeth of the two sides meet and almost cross one another, so that the rhachis must be regarded as really narrow; but it appears to be wide, because the teeth near the centre (5–6 on each side) are set much more widely apart from each other than those which follow, and are small with low hooks. Possibly this part of the radula has been artificially stretched.

Disc. fragilis is probably identical with some of the subsequently described species, and the specific name has priority (1864) over all those given by Abraham, Bergh, and later writers, but must yield to *bellicosa* (1857) if the two prove to be identical. Alder and Hancock's statement of the differences does not amount to much, but, on the other hand, there is little resemblance between their plate and Kelaart's.

DORIS PARDALIS A. & H.

= *Discodoris pardalis* (A. & H.).

Labial armature yellow, consisting of rods not jointed, fairly straight but with a slightly undulated outline. The armature was apparently composed of two separate halves originally, but is now somewhat confused.

The radula is also confused, but consists of about 28 rows, containing from 12 to 30 teeth on each side of the rhachis. The

teeth are erect, strong, but not very stout. The last one or two are reduced in size, but not degraded and still hamate. The middle part of the radula is more spaced than the rest, and 4–5 inner teeth on each side, which are lower than the others, seem to be set in the broad rhachis. But it is not clear if this position is natural.

Though this radula is narrow, it is doubtful if the animal described by me (Gardiner, Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii. part 1, p. 554) as *Disc. pardalis* var. is really referable to this species. It had a radula of only 13.0.13.

Doris concinna A. & H.

= *Discodoris concinna* (A. & H.) and
Disc. concinniformis Bgh.

Labial armature composed of two triangular plates, consisting of a dense mass of irregular and sinuous rods.

The radula consists of 17 complete rows and fragments of 3 or 4 others, with 45 teeth on either side of the rhachis in the longest rows. The innermost teeth are markedly lower than the rest and project into the wide rhachis; the outermost are smaller but not degraded.

This radula is not inconsistent with the supposition that *D. concinna* is Bergh's *D. concinniformis*. The formulæ of the radulæ examined by him are $27 \times 44.0.44$; $24 \times 37.0.37$; $31 \times 55.0.55$. Some (but apparently not all) of his specimens had thickenings on the rhachis, which are not visible in Alder and Hancock's preparations.

Doris osseosa Kelaart.

? = *Sclerodoris osseosa* Eliot, P. Z. S. 1903, vol. ii. p. 380; renamed *Peronodoris*, as this apparently identical genus has priority.

Two radulæ are preserved. They are yellow or brown, and consist of 21 and 26 rows of teeth respectively. On either side of the rhachis are from 35 to 50 teeth. The 5–6 innermost, particularly the one nearest to the rhachis, are short and slender. The rest are hamate, except the two outermost which are degraded. The 5–6 outermost decrease in size.

Since both these radulæ are unusually short, some doubt arises whether *D. osseosa* is really the same as the animal described by me *l. c.* The specimen preserved, though in bad condition, is apparently the same as mine, and, being smaller, may possibly have a shorter radula.

Doris rusticata A. & H. l. c. p. 120.

= *Staurodoris rusticata* (A. & H.).

One radula light yellow in colour, consisting of 38 rows with remains of a 39th. There are about 50 teeth on each side of the

rhachis, of which the last 5 are degraded but not denticulate, though perhaps jagged here and there. The teeth are markedly smaller near the rhachis and increase outwards, not becoming smaller again until quite the end of the row. In the front part, as preserved, the rows bend downwards and are crowded in the middle. Behind, the two sides are pulled apart, so that there seems to be a broad rhachis, on which are teeth that may possibly represent rudimentary median plates, though they may also be merely broken teeth out of place.

This dentition supports the idea that *D. rusticata* belongs to the same group as *Staurodoris verrucosa*. The genitalia are unknown.

Doris villosa A. & H. l. c. p. 119.

= *Thordisa villosa* (A. & H.).
= *Th. maculigera* Bergh.

One radula, consisting of one large piece and two fragments. The formula appears to be about 60 × 70.0.70. The teeth increase in size from the rhachis outwards. The innermost are low, with long bases. Those near the end of the row are large, strong, and distinctly hooked. The 3 or 4 outermost are different: thin, not much hooked, and with the tip divided into hair-like denticles. In some rows this formation is obscured by the medium in which the teeth are mounted, but it is quite clear in many cases.

This radula seems to place beyond doubt the identity of *Th. villosa* and *Th. maculigera*, since the type-specimen of the former possesses marginal teeth bearing hair-like denticles.

Doris spongiosa Kelaart.

Should probably be called *Trippa spongiosa* (Kelaart) = *T. areolata* (A. & H.) and *Trippa* (*Phlegmodoris*) *mephitica* Bgh.

One radula, broken and torn into two parts for most of its length. There are only 15–16 rows, each containing about 35 teeth, on either side of the rhachis. The 4–5 innermost are shorter and smaller than the rest, which are hamate, white, and erect. The last 1–2 decrease in size, but appear to be still hamate and not denticulate.

T. areolata (23 × 40.0.40) and *T. mephitica* (30 × 55.0.55) also have short radulæ of a similar character, and the identity of the three species is very probable.

Doris tristis A. & H. l. c. pp. 121–2.

? = *Trippa tristis* A. & H.

The single radula is accompanied by the note "no collar apparently," and is divided down the rhachis into two detached halves. There are only 17 rows, each containing about 28 or 30 teeth, on either side of the rhachis, but it is difficult to state the number of teeth exactly, as the innermost are scattered over the space between

the two halves. The innermost teeth are small and slight; the rest large, strong, and hamate. The last five or six gradually decrease in size.

The shortness of this radula and its other characters make it probable that the animal is a *Trippa*. Alder and Hancock thought it showed "some affinity with *D. spongiosa*," and it apparently had compound tubercles ("swellings . . . . and a few tubercular elevations; the surface is also covered with minute tubercles, particularly on the ridges and swellings").

Doris leoparda Keelart.

Should probably be called *Trippa leoparda* (Kelaart)=*Trippa monsoni* Eliot.

The animal depicted in my previous paper in figure 1 of Plate XLV. is inadvertently called *Trippa monsoni* in the explanation of the plates on page 690. It should be called *Doris leoparda*, for though the two animals are probably the same, the figure reproduced is Kelaart's sketch of *D. leoparda*, which, if it proves to be a *Trippa*, should be called *Tr. leoparda*.

Trevelyana ceylonica Kelaart.

Eliot, Proc. Zool. Soc. 1904, vol. ii. pp. 86–7.

The radula shows that the animal described by me is, as conjectured, Kelaart's *Trevelyana ceylonica*. It consists of 21 rows, each containing 24–25 teeth, on either side of the rhachis. The first lateral is larger than the rest and differently placed, so as to project into the rhachis. All the teeth are awl-shaped.

Goniodoris.

The buccal parts of *G. aspersa* and *G. citrina* are preserved, but in both the teeth are covered with flesh, so that the small teeth cannot be seen at all and most of the large ones are only partly visible. No formula can be given.

The large teeth of *G. aspersa* have a kink in the lower part of the back and a distinct ridge or wing at the side, but no denticles or striations. There is a buccal ring studded inside with prominences.

None of the teeth of *G. citrina* can be seen completely, but the upper part clearly bears very fine striations, and it would seem that the outline is not a regular curve but swells outwards both on the back and on the inside. Other parts of the buccal mass are preserved, but there is no trace of an armature.

Eolis militaris A & H.

=*Hervia militaris* (A. & H.).

Fourteen teeth are preserved. They are of the horseshoe shape, with rather long side-limbs. The central cusp is distinct and well formed: on either side are 7 denticles about half its size and close to one another.

The jaws bear a single row of distinct blunt denticles, set at some distance from one another. Some of them show traces of bifurcation at the tip.

As Farran has observed (*l. c.* p. 331), this species seems to be a *Hervia*, although Bergh (System, p. 1032) suggested it might be a synonym of *Facelina rubrovittata*. But both the description and figure of Alder and Hancock represent the rhinophores as smooth.

DORIDOPSIS and DORIOPSILLA.

An error occurs in the numbering of the figures representing these genera on Plate XLVII. of my previous paper, as published in the Society's 'Proceedings,' although the numbers are correct in the copies printed separately. Numbers 4 and 5 should be transposed; that is to say, the lower figure represents *Doridopsis nigra* and should be numbered 5, while the upper figure represents *Doriopsilla miniata* and should be numbered 4.

7. On Variations in the Arterial System of certain Species of the Anura. By LIONEL R. CRAWSHAY, M.A.*

[Received October 22, 1906.]

(Text-figures 143–155.)

In the original and subsequent editions of Ecker's and Wiedersheim's 'Anatomie des Frosches,' the species employed for investigation were exclusively *Rana esculenta* Linn. and *Rana temporaria* auct., and particularly the former. The species *R. catesbiana* Shaw and *R. silvatica* Leconte were also, it is stated, examined by Ecker for comparison, but no reference is made to them in the text. Besides the portion of these works devoted to the subject, which has been so greatly extended by Gaupp in the last edition, there is, so far as I am aware, no other published record dealing with the general arterial system of the Anura, so that the work, it would seem, has so far been practically confined to the two first-named species. While working a short time ago, by the kindness of Mr. Beddard, at the Prosectorium of the Zoological Society's Gardens, I was very greatly indebted to him for enabling me to examine, in addition to the above named, certain other species of the Anura, in some of which a considerable portion of the arterial system was worked out in detail. These comprised single specimens of *Rana catesbiana* Shaw, *R. tigrina* Daud., *R. hexadactyla* Less., *Bufo boreas* B. & G., and *B. mauritanicus* Schleg., and two specimens of *Rana clamata* Daud.

It is true that the extent of variation, sometimes even in important points, to which the arteries are liable in individuals

* Communicated by F. E. BEDDARD, M.A., F.R.S.

of the same species, considerably lessens the importance attaching to such variations as may occur between isolated individuals of different species. Dealing with limited material, the present paper is submitted in the hope that it may not be without value as a contribution to the further study of the subject, and more especially perhaps from the wider aspect of the arterial system of the Anura as a whole.

In the portion of the arterial system here considered, the *Aa. carotis cerebralis, occipito-vertebralis, brachialis,* and *ischiadica* are omitted. The species will be considered together as far as possible, the account in Gaupp's edition of Ecker's and Wiedersheim's 'Anatomie des Frosches' being followed as a basis of reference. The nomenclature of the arteries is that adopted in the same work, but in the case of the muscles the system used in the original edition of Ecker is retained. In regard to the latter, among the muscles to be referred to a difference of nomenclature occurs in the following:—

Ecker.	Gaupp.
M. coraco-humeralis.	= *M. coraco-brachialis longus.*
,, *ileo-psoas.*	= ,, *iliacus internus.*
,, *infraspinatus.*	= ,, *dorsalis scapulæ.*
,, *levator anguli scapulæ.*	= ,, *levator scapulæ inferior.*
,, *obliquus internus.*	= ,, *transversus.*
,, *subscapularis.*	= ,, *coraco-brachialis brevis.*
,, *transverso-scapularis major.*	= ,, *serratus inferior.*
,, ,, ,, *minor.*	= ,, ,, *medius.*
,, *triceps brachii.*	= ,, *anconeus.*

The *A. bulbi cordis* had not in all cases the same point of origin. In *R. tigrina, R. clamata,* and *R. catesbiana,* it arose from the base of the right carotid arch; in *R. hexadactyla,* the same, but close against the margin of the right systemic; in *Bufo boreas* from the base of the right systemic; in *Bufo mauritanicus* from the base of the left carotid arch. In each case, the artery ran across the base of the three right arches and divided into branches supplying the dorsal and ventral sides of the bulbus but not apparently extending beyond it.

I. Carotid System.

The *A. carotis externa* appeared in *Bufo boreas* to arise from near the centre of the carotid gland, instead of from its proximal margin as in other species.

The *r. musculo-glandularis* was given off a short way from the base of this artery in all the species, supplying vessels to the thyroid gland and hyoidean muscles in this region. The close association of this branch with the thyroid was especially well exhibited in *R. hexadactyla* and *R. tigrina,* where the gland was much broken, and a branch of the artery ran in communication with the several disconnected portions. It is remarkable,

however, that in *Bufo boreas* a large dark reddish compact gland attached ventrally to the distal end of the middle and posterior arches, and similar in appearance to the thyroid, had no connection whatever with this artery, but was supplied on both sides of the body by a branch of the subclavian*.

From the point where the *r. lingualis* passes backwards to the tongue, a small branch of the *carotis externa* is continued forwards in the *M. geniohyoideus* to the edge of the lower jaw. In *R. tigrina* and both species of *Bufo* this vessel ended here, but in the rest of the species examined it formed an anastomosis with the *r. maxillaris inferior* of the *A. occipitalis*.

A. carotis interna.—I was unable to observe the *A. pharyngea ascendens* described and figured by Ecker, and afterwards in the translation of Haslam, as a branch of this artery in any of the specimens examined, but in all cases the first subdivision of the artery occurred just as it enters the inner posterior angle of the orbit and passes into the skull, giving off the *Aa. ophthalmica* and *palatina* with other unimportant small vessels almost simultaneously. There is no reference to such a branch of the carotid in Gaupp's edition, and unless its insertion can have been due to some error, its occurrence as a noteworthy vessel would seem to be abnormal.

The connection of the *A. palatina* with the Harderian gland was always very marked, the main vessel turning inwards to the gland as it reached the anterior border of the orbit. This gland occupied a constant position against the eyeball in close contact with the *M. obliquus inferior*. In *R. hexadactyla* it formed the centre of a complete anastomosis between the *Aa. palatina* and *ophthalmica*, and the *orbito-nasalis* and *maxillaris superior* of the *occipito-vertebralis*, the *palatina* uniting with the *orbito-nasalis* just before reaching the gland. The gland in this case especially was completely suffused with the colour of the injection, as is so noticeable in the spleen, or, less distinctly, in the thyroid (text-fig. 147, *g.h.*, p. 1019).

II. Systemic System.

The *A. laryngea* was constant in occurrence and position, leaving the systemic arch opposite to the carotid gland.

As the systemic arch passes up to the dorsal body-wall, the first trunk to be given off was in all cases the *occipito-vertebralis*, the *subclavia* very soon afterwards branching off from the aorta and crossing the base of the *occipito-vertebralis* dorsally in its outward course.

The *A. œsophagea* seems in most cases to arise from the base of the *occipito-vertebralis*. Such was the case in *R. clamata*, *R. hexadactyla*, *R. tigrina*, *B. mauritanicus*, and *B. boreas*. In *R. tempo-*

* No attempt is made here to discriminate between the several factors which may make up the sometimes very irregular glandular masses in this region, and the term "thyroid" is used for them collectively with some reticence (cp. H. Norris, Anat. Anz. vol. xxi. p. 221).

raria it originated in one specimen on both sides of the body in the aorta, just behind the origin of the *subclavia*, while on the left side there was an additional vessel from between the *subclavia* and the *occipito-vertebralis*. In another individual of the same species it arose on both sides from the base of the *occipito-vertebralis*.

In *R. catesbiana* it originated between the *subclavia* and the *occipito-vertebralis*. It divided on the œsophagus, and the main portion ran as a rather large vessel for a considerable way down the right side of the stomach, supplying a large portion of the cardiac region, over which it formed a close network. A branch of this network could easily be traced to the right lung, where it formed an anastomosis with branches of the pulmonary artery. Further back, its ramifications united with those of the *ramus sinister* of the *A. cœliaca*. The point is not without interest as showing how, ultimately, as one may conceive, through the medium of such anastomoses a distinct vessel might arise in a purely secondary manner running either from the *œsophagea* or the *cœliaca* directly to the lung.

A. subclavia.—The branches of this artery distributed to the pectoral girdle are liable to much variation in number, structure, and distribution. I am inclined to think that a careful examination of a large number of individuals is still needed to establish a satisfactory type of arrangement for the Anura. Two figures are appended showing their arrangement on both sides of the body in two individuals of *R. temporaria* which were injected together for the purpose (text-figs. 143, 144, p. 1012). Here, before the radial artery was given off, there were five (in one case four) arteries striking out at irregular intervals into the pectoral girdle, roughly with an anterior and posterior alternation. Retaining so far as possible the nomenclature of Gaupp :—

(1) The *A. thoracica superior*, arising from near the *occipito-vertebralis*, took, in one of these two individuals, the usual course upwards and forwards, supplying the *Mm. intertransversarius capitis superior* and *levator anguli scapulæ* on both sides of the body. In the other individual, the artery went on one side to the *M. transverso-scapularis minor*, and on the other side entirely backwards to the *M. obliquus internus*.

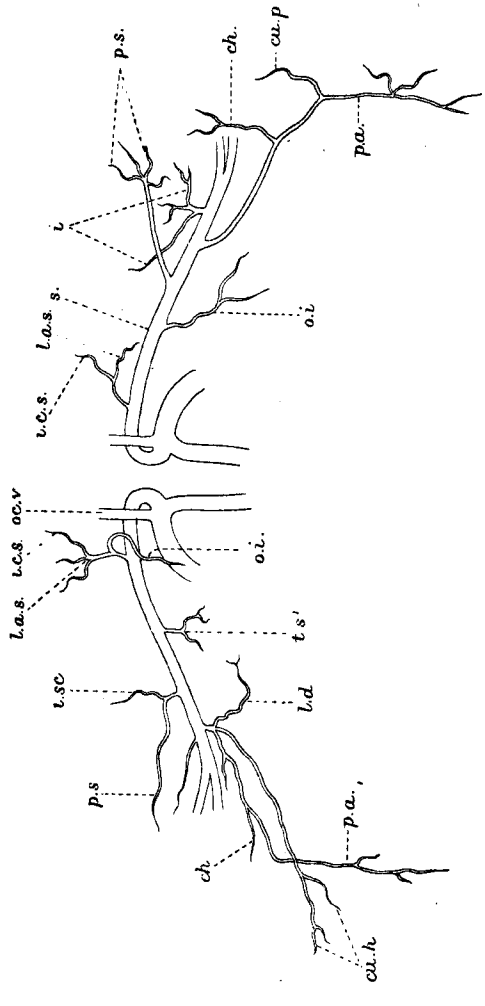
(2) The *A. thoracico-abdominalis* went in three cases almost entirely to the *M. obliquus internus*; in the fourth case to the *M. transverso-scapularis major*.

(3) The *A. coraco-clavicularis*, perhaps the most constant member of the subclavian system, passed mainly in all cases through the coracoid foramen to the *M. pectoralis sternalis*, a branch being given in two cases to the *M. interscapularis*.

(4) This, the largest branch, appeared in all four cases to be a combination of the *Aa. dorsalis scapulæ posterior* and *dorsalis scapulæ anterior* of Gaupp. In three cases a branch went to the *M. pectoralis abdominalis*, but on all four sides one or more conspicuous branches ran to the skin of the upper arm or that of the

pectoral girdle; other muscles supplied being the *Mm. latissimus dorsi*, *infraspinatus*, *coraco-humeralis*, *subscapularis*, and in one case the *obliquus externus* and *obliquus internus*.

Text-fig. 143.

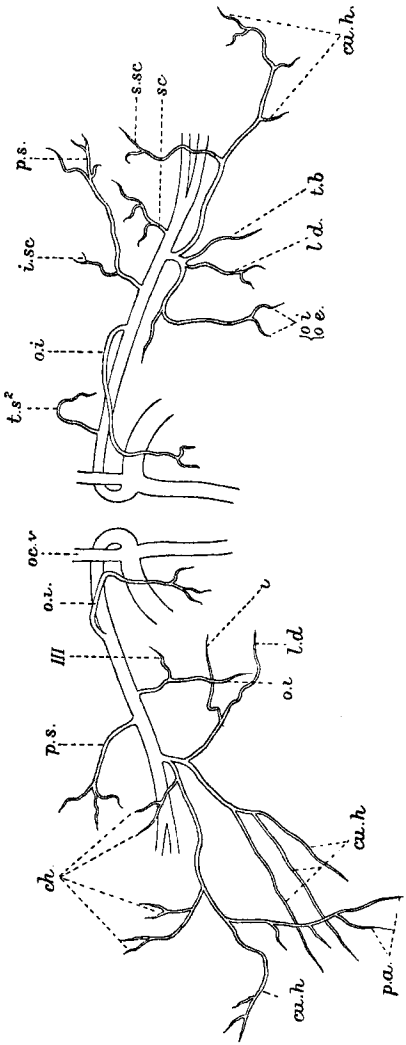


Rana temporaria (× 2).

Ventral view of *Aa. subclaviæ*.

(For explanation of the lettering, see p. 1033.)

Text-fig. 144.



Rana temporaria (× 2).

Ventral view of *Aa. subclaviæ*.

(For explanation of the lettering, see p. 1033.)

(5) This branch, apparently the *A. pectoralis superior*, was absent on one side in one individual, but in the other three cases went irregularly to the *Mm. scapularis* and *infraspinatus* and the scapula respectively.

With regard to the other species, the two specimens of *R. clamata* (text-fig. 145, p. 1015) agreed with one another and with the above account in the main points. On the (right) side of the body examined, the *a. thoracica superior* had a forward and upward direction, going chiefly in one specimen to the *M. intertransversarius capitis superior* and in the other to the *M. levator anguli scapulæ*. The *thoracico-abdominalis* went to the *Mm. obliquus internus* and *transverso-scapularis major*. The *coraco-clavicularis* passed through the coracoid foramen. The fourth branch went to the *Mm. pectorales sternales* and *latissimus dorsi* and to the skin under the pectoral girdle. The fifth, which is omitted from the figure, went to the scapular region.

In *R. hexadactyla* (text-fig. 147, p. 1019) there were the same five branches. The distance between the first two was much exaggerated in the figure to avoid confusion. The *thoracico-abdominalis* after supplying the *M. transverso-scapularis major*, ran back as an exceptionally long vessel in the substance of the *Mm. obliquus externus* and *obliquus internus*. The fourth branch was divided between the *Mm. latissimus dorsi* and *subscapularis*, the cutaneous portion being absent. The fifth branch supplied the *M. infraspinatus*.

In *R. catesbiana* (text-fig. 146, p. 1017) there were nine distinct branches. Their relations will be more easily understood by reference to the figure of this species, where, as elsewhere, though at the risk of confusion, diagrammatic arrangement has been avoided as far as possible. Probably the third, fifth (posterior), sixth, seventh, and ninth branches are to be homologised with the five referred to above; the first, second, fourth (anterior), and eighth being additional ones. On the side of the body that is figured the third branch, presumably the *thoracica superior*, had completely united with the *ramus auricularis* of the *cutanea* so as to be distributed in common with that artery to the tympanic region. On the left side, after passing round the region of the atlas, it formed a fine anastomosis under the hinder border of the tympanic membrane with the same branch of the *cutanea*. A second anastomosis was formed here between the fourth (anterior) branch and a twig from the *coraco-clavicularis*, the latter artery passing almost entirely through the coracoid foramen. The small fourth and eighth branches followed the first and third spinal nerves respectively.

R. tigrina was remarkable for the fact that the *thoracica superior* and the *thoracico-abdominalis* were each of them represented by a pair of arteries, the first pair supplying chiefly the *M. intertransversarius capitis inferior*, and the second pair almost wholly the *M. obliquus internus*. Then followed, thirdly, the *coraco-clavicularis*, passing wholly through the coracoid

foramen; fourthly, the largest branch distributed for the most part to the skin of the upper arm and under the pectoral girdle and to the *M. latissimus dorsi*; and lastly, the branch elsewhere identified as the *pectoralis superior*, to the *Mm. infraspinatus* and *latissimus dorsi*. On the left side of the body there was no difference to mention beyond the fact that the first pair (*thoracica superior*) were closer together and the second pair (*thoracico-abdominalis*) farther apart than on the right side.

In *Bufo mauritanicus* the *thoracica superior* was absent from the *subclavia*, its place being taken by a small branch from the *occipito-vertebralis* just beyond the *œsophagea*. The first branch, moreover, to arise from the *subclavia* was not the *thoracico-abdominalis* but the *coraco-clavicularis*. A branch of this latter artery went through the coracoid foramen, but the greater portion of it passed round the *M. scapularis* to break up over that muscle, the posterior portion of the *M. pectoralis sternalis*, and the skin of the upper arm. Very shortly after this arose the *thoracico-abdominalis*, distributed almost wholly to the *M. obliquus internus*, but sending also a twig to the *M. transverso-scapularis major*. Lastly arose the *pectoralis superior* supplying the *M. infraspinatus* and the scapula. The condition of the left side scarcely differed at all from that of the right.

In this Toad there were, therefore, only three branches from the *A. subclavia*.

In *B. boreas* (text-fig. 153, p. 1029) the branches were five, their arrangement being, roughly speaking, similar to that described above for *R. temporaria*. The *thoracico-abdominalis* went almost wholly to the *M. transverso-scapularis major*, a small twig on the left side only being given to the *M. obliquus internus*. The most remarkable point was that the *coraco-clavicularis* did not arise independently, but in common with quite a new artery which shortly separated from it and ran direct to the gland which has already been referred to as lying upon the distal ends of the systemic and pulmo-cutaneous arches. The condition was identically the same on both sides of the body. A large portion of the fourth branch went to the *M. triceps brachii*. The fifth branch, which was large, arose opposite to the latter branch and supplied the *Mm. infraspinatus* and *deltoideus*, the scapula, and the skin of the humeral region.

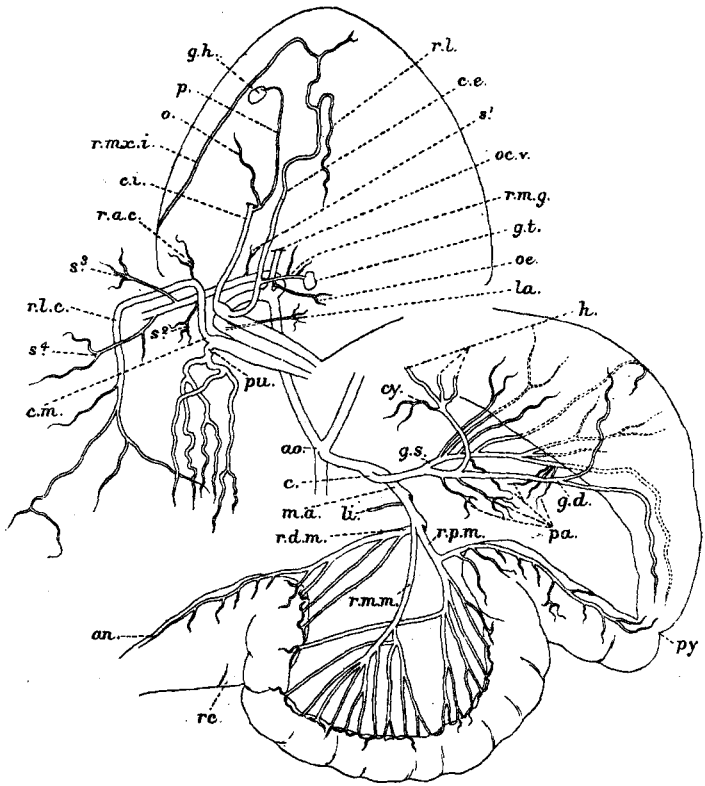
Passing to the consideration of the *Aorta abdominalis*, the cœliaco-mesenteric axis arose in all cases from the left side of the point of union of the two aortic arches, that is apparently as a continuation of the left arch.

In *Bufo mauritanicus*, a vessel about as large as the *A. lienalis* arose from near the origin of the cœliaco-mesenteric axis and ran back in the mesentery, dividing into two branches, of which the posterior one extended to the anterior border of the left kidney without traversing its substance, and the anterior one went to the mesentery. This would seem to be properly one of the *Aa. urogenitales*, its origin having become displaced from the main

trunk of the aorta. In a specimen of *R. temporaria* the first of the true *Aa. urogenitales* arose so close to the base of the cœliaco-mesenteric axis that it might almost be said to arise from it.

A. cœliaca.—The distinction of *sinistra* (*dorsalis*) and *dextra* (*ventralis*) as applied to the two divisions of the gastric system was clearly marked with few exceptions, the two branches supplying the left and right sides of the stomach respectively. The only exceptions of any importance were both specimens of

Text-fig. 145.



Rana clamata, ♀ (× 1½).
Portion of arterial system. Ventral view.

(For branches of *A. subclavia*, s^1–s^4, see p. 1013. For explanation of other lettering, see p. 1033.)

R. clamata, in which the right (ventral) side received two or three important vessels from the left artery. Except in *R. tigrina* and both species of *Bufo*, there was no vessel given off before the *A. gastrica sinistra*.

A. gastrica sinistra.—This artery is liable to considerable variation, even in individuals of the same species. In this respect, three specimens of *R. temporaria* were all different. Here, from two to four vessels were given off to the cardiac region of the stomach, sometimes dividing before reaching it. The direction of the main trunk was always towards the median point, about which the artery then either simply bifurcated, or further subdivided while in the omentum, the posterior branch in either case running down the left wall of the stomach to the pylorus.

Within the limits of this variation, *R. clamata*, *R. hexadactyla*, and *R. esculenta* scarcely differed from *R. temporaria*. *R. tigrina* showed a greater tendency to division in the omentum, the artery simply giving off five or six subequal branches in a more or less regular series, the last of which became attached to the stomach not far in front of the pylorus. In this species, the first gastric vessel was given off from the *A. cœliaca* before the origin of the *A. gastrica sinistra*.

In *R. catesbiana*, three minute vessels were first given off anteriorly to supply the omentum, then a single branch to the cardiac region of the stomach, the remainder to the very long pyloric region (in this individual), reaching it in five vessels, of which the last ran down as usual to the pylorus.

In *Bufo boreas* and *B. mauritanicus*, the first gastric vessel was given off before the origin of the *A. gastrica sinistra*. The latter artery then very shortly gave off a single gastric vessel and afterwards divided into two branches, which at once became attached to the stomach near its median point and continued to break up over its substance, the posterior branch following the usual course to the pylorus. There was therefore very little tendency here to early division in the omentum, as also was the case in *R. hexadactyla*.

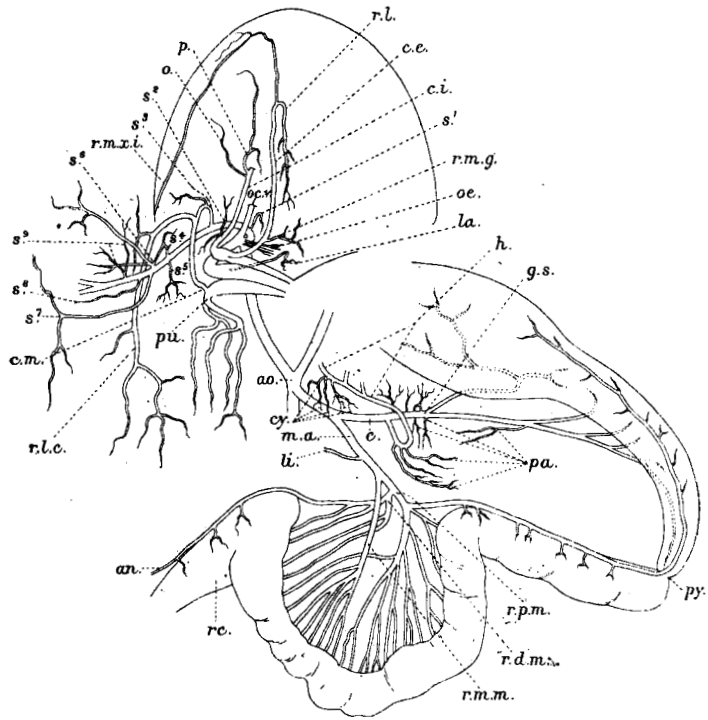
In both specimens of *R. clamata* two or three branches of this artery went to the right side of the stomach. In all other cases it was almost entirely distributed to the left side.

There is no mention made by Gaupp of branches from the *A. gastrica sinistra* supplying the pancreas. The artery, however, commonly sends back one or more small branches to that gland, which vary in number and position. In *R. temporaria* there were two in two individuals and three in a third. In *R. esculenta* one, near the origin of the artery and some way before the first gastric vessel. In *R. catesbiana* two before the first gastric vessel and a third distally. In *R. clamata* four in one individual. In *R. tigrina* five. In *R. hexadactyla* one after the first gastric vessel sending a branch backwards to the pancreas and then following the bile-duct &c. nearly to the liver, also three small ones. In *Bufo boreas* and *B. mauritanicus* three; in the latter species rather close together and from the distal portion of the artery (text-figs. 145, 146, 147, 153).

A. hepatica.—This artery was in all cases given off not far

beyond the origin of the *gastrica sinistra*. In *B. mauritanicus* and *B. boreas* the pancreas received two vessels from it: in the former species both from near the base; in the latter, one from near the base, the other from more than halfway towards the gall-bladder. But I did not observe the presence of pancreatic branches in the other species, except in *R. temporaria*, where one occurred in two individuals and two in a third.

Text-fig. 146.



Rana catesbiana, ♂ (× ⅔).

Portion of arterial system. Ventral view.

An abnormal individual, with *A. gastrica dextra* absent.

s^1–s^9.—Branches of *A. subclavia*. (The numbers have no morphological significance.)

s^1 to wall of aorta.
s^2 to *Mm. levator anguli scapulæ* and *obliquus internus*.
s^3 anastomosing with *r. auricularis* of *A. cutanea magna*.
s^4 to hypoglossal nerve.
s^5 to *Mm. obliquus internus* and *transverso-scapularis major*.
s^6 through coracoid foramen to *M. pectoralis sternalis*, with a branch to *M. subscapularis*.
s^7 to *M. pectoralis abdominalis* and skin below pectoral girdle.
s^8 to 3rd spinal nerve.
s^9 to *Mm. transverso-scapularis major* and *deltoideus*.

(For explanation of other lettering, see p. 1033.)

A. gastrica dextra.—A varying number of vessels were given off from this artery to the pancreas and adjacent structures as follows:—In *Bufo boreas* one, some distance beyond the *A. hepatica*; in *B. mauritanicus* one, from near the stomach; in *R. hexadactyla* one; in *R. esculenta* two, opposite the origin of the *hepatica*; in *R. clamata* (two specimens) one, in the same position; in *R. tigrina* two.

(In addition to these vessels, the pancreas also received a single vessel from before the origin of the *hepatica* in *R. esculenta*, *R. hexadactyla*, and *R. tigrina*.)

The specimen of *R. catesbiana* (text-fig. 146, p. 1017) was remarkable for the fact that after the separation of the *gastrica sinistra*, three arteries were shortly given off to the pancreas and then the remainder of the *A. cœliaca* went to the liver and gall-bladder, the *gastrica dextra* being entirely absent. It is conceivable that this abnormality might be correlated with the anastomosis which so frequently occurs on the right side of the pylorus between the normally present *gastrica dextra* and the duodenal branch of the *mesenterica*. In this case, moreover, the latter artery was continued without diminishing in size over the pylorus and up the right side of the stomach; in fact over the region which the *A. gastrica dextra* would normally traverse. In this individual, a male, which was sent to me alive from America, the constricted pyloric region was extremely long. In another, a large female of the same species which was examined for comparison, the condition of the arteries here was quite normal, and in this latter case the constricted pyloric region was very short.

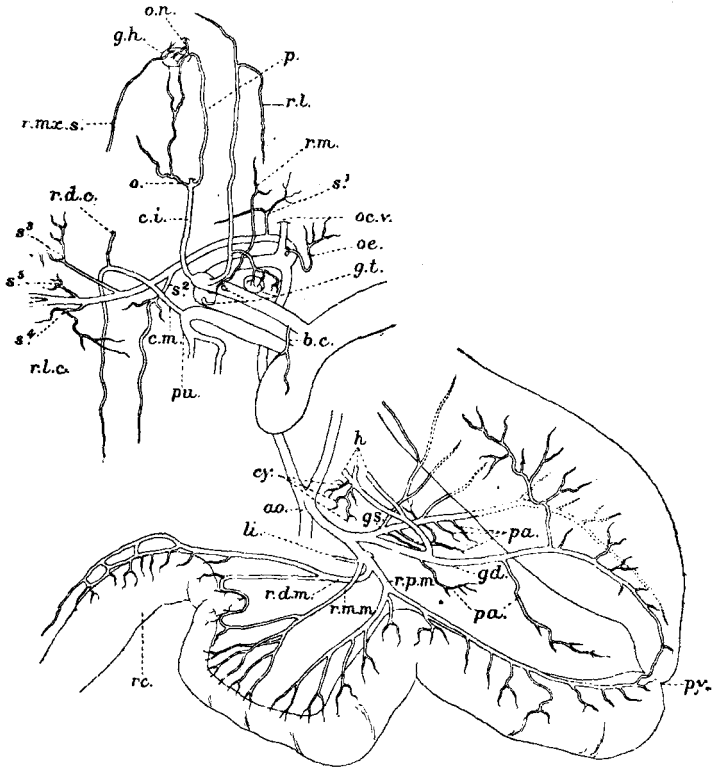
In the other species, the *A. gastrica dextra* was continued as a rather larger vessel than the *A. hepatica* to the right side of the stomach and towards its more distal portion. In three individuals of *R. temporaria* it only varied in the relative points of its division. It divided into two branches at about two-thirds of the way to the stomach, and each branch again divided into two near the latter.

In *R. esculenta*, the first division of the *A. gastrica dextra* took place closer to the stomach and the posterior branch was continued as a compact vessel down to the pylorus. In *R. tigrina*, it began to divide about halfway to the stomach, which it reached in three or four branches. In *R. clamata* and *R. hexadactyla*, it divided into an anterior and posterior branch on or near the surface of the stomach (text-fig. 145, p. 1015; text-fig. 147, p. 1019). *Bufo mauritanicus* somewhat resembled *R. tigrina*, but the subdivision of the artery was more distal. *B. boreas* was very distinct from the rest by the simultaneous division of the artery close to the stomach into five equal-sized branches, the posterior branch running back as usual to the pylorus, the others breaking up at short intervals in front of it (text-fig. 153, p. 1029).

A. mesenterica anterior.—The extent of variation in this artery is so great that it is difficult to draw more than very general comparisons between the species under consideration.

The *A. lienalis* was given off some way before any other branch in *R. temporaria*, *R. catesbiana*, *R. clamata*, and *B. boreas*; and just before or immediately opposite to one or more of the intestinal branches in *R. esculenta*, *R. tigrina*, *R. hexadactyla*, and *B. mauritanicus*, always as a single vessel.

Text-fig. 147.



Rana hexadactyla, ♀ (× 1½).
Portion of arterial system. Ventral view.

s^1–s^5.—Branches of *A. subclavia*.

s^1 to *Mm. transverso-scapularis major, longissimus dorsi*, and *transverso-scapularis minor*.
s^3 through coracoid foramen to *M. pectoralis sternalis*.
(For other branches, see p. 1013. For explanation of other lettering, see p. 1033.)

The intestinal portion of the artery is divided by Gaupp into two portions, distinguished as *rr. intestinales* and *rr. hæmorrhoidales anteriores* respectively. Viewing the species under consideration as a whole, it seems rather to fall into three distinct branches.

The arrangement was rather different in the two species of *Bufo*, but in all the six species of *Rana* it may be said that the independence of these three branches and their association respectively with the proximal, median, and distal portions of the intestine was distinctly marked. For purposes of comparison I will therefore refer to them as the *proximal*, *median*, and *distal* rami.

The *proximal ramus* soon divides in the mesentery near the end of the first loop of the intestine. A large branch is then given off which soon attaches itself to the surface of the gut, running along the duodenum to the pylorus, where it generally anastomoses with the distal portion of the *A. gastrica dextra*. As previously mentioned, in *R. catesbiana* it took up the whole function of that artery, running for a considerable way up the right side of the stomach (text-fig. 146, p. 1017). *R. tigrina* and one specimen of *R. clamata* were the only examples in which no such anastomosis was observed. In *Bufo mauritanicus* a small vessel was given off at the bile-duct (*A. pancreatica posterior*, Gaupp) and ran a considerable way along it, supplying the pancreas, &c. This vessel was also present in one specimen of *R. temporaria*, and may have escaped my notice in other individuals, though I did not observe it. The other portion of this branch of the *mesenterica anterior* runs backwards, and normally, unlike the duodenal portion, shortly breaks up in the mesentery into a variable number of vessels which mostly further subdivide, confining themselves roughly to the first half of the small intestine. Such was the case in *R. temporaria*, *clamata*, *tigrina*, *catesbiana*, and *hexadactyla*. In *R. esculenta*, instead of division in the mesentery, a single vessel ran along the wall of the intestine like the duodenal portion. *Bufo boreas* was the same as *R. esculenta*. In *B. mauritanicus* the intestinal portion took off from the main trunk quite independently of the duodenal portion of this ramus and more distally.

The *median ramus* runs for some distance unbroken and then divides and subdivides rapidly in the mesentery into a number of vessels, which are distributed roughly to the distal half of the small intestine. The variation to which this branch is liable among individuals of a species seems to be too great to admit of comparison being drawn between the species themselves.

The *distal ramus* (*rr. hæmorrhoidales anteriores*, Gaupp) is, as a rule, almost confined in its distribution to the large intestine. *R. tigrina* was exceptional in that about one-third of it went to the small intestine. More often its first vessel reaches the gut nearly on the border line between these two regions. Its independence as a distinct unit of the mesenteric system was clearly shown in all the species except in *B. boreas*, where it was more difficult to differentiate it from the *median ramus*. In *R. tigrina* it was very much broken up in its course through the mesentery. In *R. esculenta* it reached the intestine as a single vessel only. Posteriorly, it usually runs back in close contact

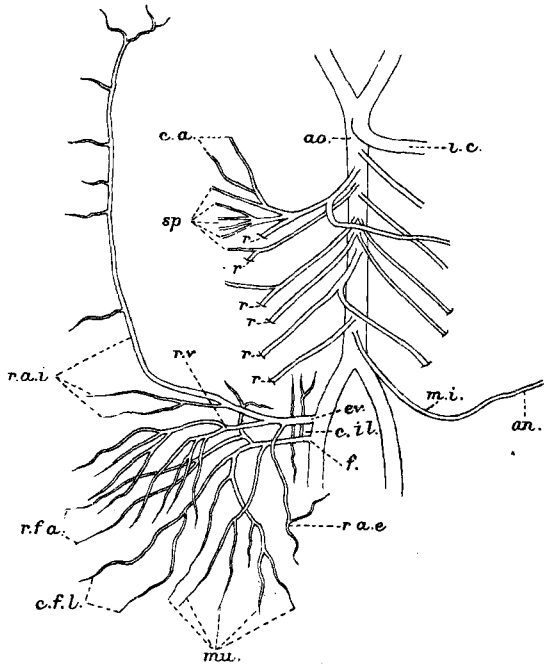
with the large intestine, giving off twigs on the way, to the cloacal region; but in this respect *R. hexadactyla* was an exception, the main vessel running freely in the mesentery beside the gut, while its subdivision formed a series of anastomoses which gave it a fenestrated structure (text-fig. 147, p. 1019). Near the distal end of this posterior vessel an anastomosis is often formed with the *A. mesenterica inferior* from the aorta, but the occurrence or non-occurrence of this seems to be quite accidental.

In connection with the *A. mesenterica anterior* a point may be mentioned here which possibly has not escaped the notice of others, namely, the giving off of a vessel from a branch of the artery to a region of the intestine quite outside the sphere with which that branch and its vessels are concerned. Notwithstanding the approximation of different regions of the intestine that may occur owing to the folding of the mesentery, there is normally no true overlapping of the vessels; that is to say, their respective regions of distribution remain distinct, and even the minor vessels do not cross one another. But in certain cases a departure from this occurred. Thus in *R. clamata* (text-fig. 145, p. 1015) one of the vessels of the *median ramus* crossed under all its fellows behind it and went out of its way, so to speak, to the extreme end of the small intestine; and in a more remarkable degree, one of the vessels of the *proximal ramus* struck across under the whole of the *median ramus* to a point on the intestine behind all the vessels of the latter. Both of these points were repeated in the second specimen of *R. clamata*. In *R. catesbiana* there was no crossing of the vessels of the *median ramus*, but a vessel from the *proximal ramus* passed back under all those of the *median ramus*, reaching the intestine behind them; and the same was the case in *B. mauritanicus*. In *R. temporaria* one individual had the same irregular vessel from the *proximal ramus* only; another individual had two such vessels from the *median ramus* only. In the other species nothing of the kind occurred. There was sometimes a very close attachment between these irregular vessels and those crossed by them, but there was no union between them. In fact, while the extreme distal portions of the arteries often combine, even so as to form a continuous vessel along the wall of the gut, I observed no case of anastomosis where the vessels lie free in the mesentery, excepting the fenestrated arrangement previously mentioned in *R. hexadactyla* near the wall of the large intestine, and a union between two vessels of the *A. gastrica sinistra* close to the stomach in one specimen of *R. clamata*.

Aa. urogenitales.—These arteries have often been inaccurately described as arising from a series of unpaired stems which bifurcate right and left. As pointed out by Gaupp, such an arrangement is subject to much variation. In two of the species under consideration, namely *R. hexadactyla* and *B. boreas* (text-fig. 149, p. 1023; text-fig. 151, p. 1026), they all of them arose from unpaired stems in the aorta, which divided into right and left branches to the urogenital organs on either side. But in all other cases, traces

of the more primitive condition were more or less retained. In a specimen of *R. temporaria* each side received ten arteries, three of which arose independently from the aorta. In *B. mauritanicus* there were four vessels, three of which divided into right and left branches, the fourth going to the right kidney alone. In *R. clamata*, five vessels went to one side and four to the other. Of these nine vessels, five had independent origins (text-fig. 152, p. 1027). In *R. tigrina* on each side there were eight arteries, three of which were distinct in origin. In *R. catesbiana* there were six arteries to each side, four of them arising quite independently from the aorta, so that here there were only two which bifurcated right and left (text-fig. 148).

Text-fig. 148.



Rana catesbiana, ♂ (× 1).
Ventral view of *Aa. urogenitales*, &c.
(For explanation of the lettering, see p. 1033.)

With a doubtful exception and one clear case in a specimen of *R. temporaria*, the *Aa. genitales* did not arise, in any of the individuals examined, independently from the aorta, but always in common with a renal vessel. Generally they separated from the renal vessel a considerable distance from the aorta, but sometimes

close to it, as in the first pair in *R. hexadactyla*. In cases noted the gonads were supplied as follows, the number of urogenital arteries present in each case being placed in brackets:—

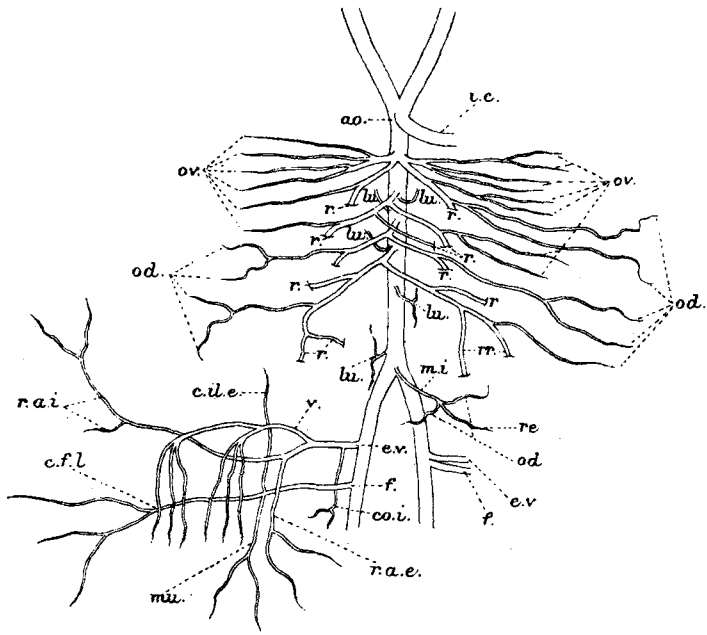
(1) TESTES:—

R. temporaria, one specimen (10 pairs): genital arteries from the first four on each side.
B. mauritanicus ($3\frac{1}{2}$ pairs): from the first two on each side.
R. catesbiana (6 pairs): mainly from the first artery on each side, but also partly from the second and third.
R. tigrina (8 pairs): from the first artery on each side.

(2) OVARIES:—

B. boreas (5 pairs): from the first four on each side and also on one side from the fifth.
R. hexadactyla ($4\frac{1}{2}$ pairs): from the first two on each side.
R. clamata ($4\frac{1}{2}$ pairs): from the first three on each side.

Text-fig. 149.



Rana hexadactyla, ♀ (× 2).
Ventral view of *Aa. urogenitales*, &c.
(For explanation of the lettering, see p. 1033.)

In the three individuals in which they were examined, the oviducts were supplied by separate branches from the *Aa. renales*,

not from the *Aa. ovaricæ*, otherwise from the *A. mesenterica inferior* (*R. hexadactyla*), or from the *A. epigastrico-vesicalis* (*R. esculenta*); the details being as follows:—

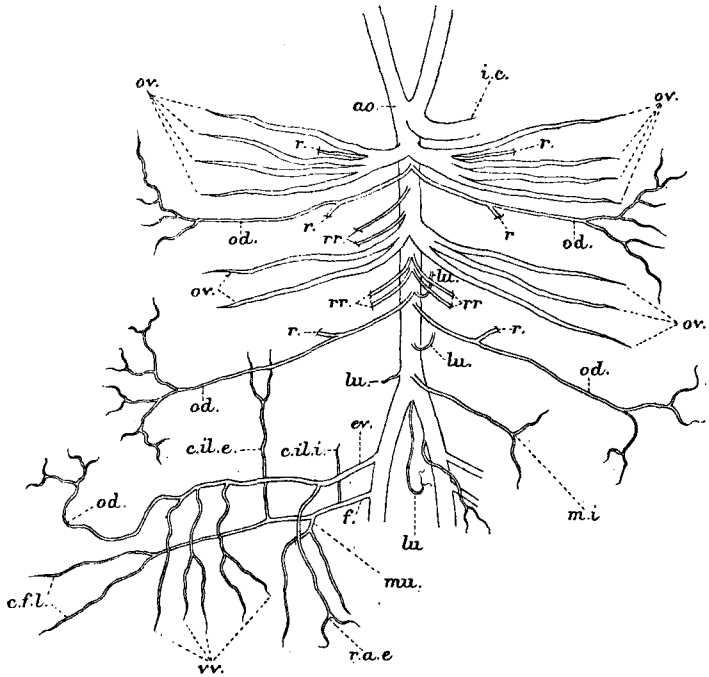
R. hexadactyla: from the first *renalis* on one side, and from the last *renalis* and the *mesenterica inferior* on both sides.

B. boreas: from the first two *renales* on one side, and the fifth *renalis* on both sides.

R. esculenta: from the second and last *renales* and the *epigastrico-vesicalis* on both sides.

The fat-bodies, as observed in three species only, were supplied by branches from the first urogenital pair and, except on one side in *R. temporaria*, direct from a genital vessel. In this exception there was no genital vessel on this side, and the artery arose from a renal vessel.

Text-fig. 150.



Rana esculenta, ♀ (× 1⅔).
Ventral view of *Aa. urogenitales*, &c.
Showing abnormal development of *Aa. ovaricæ*.
(For explanation of the lettering, see p. 1033.)

In the single individual examined of *R. esculenta* (text-fig. 150) the condition of the *Aa. ovaricæ* was very remarkable. They arose

in two paired series, each pair separating close to the aorta from a common origin and forming from two to four branches to each ovary. All of the arteries were invested throughout by a thick muscular coating from the aorta to their fine ramifications in the ovaries. Owing to this, each of the short stalks from which they arose appeared in thickness nearly to cover the diameter of the aorta. The lumen of the arteries themselves was of the usual small size. While all of the *ovaricæ* were as described, all of the *renales* were quite normal, including the first pair, which separated from a common origin with the first set of *ovaricæ*. In the figure, these thickenings appear to arise at the aorta, but they were in fact continued closely round this and attached above it by small belts of fibres to either side of the sixth and seventh vertebral centra, being connected at the same time with the sympathetic nervous system. The ovaries were very fully developed. This peculiar condition of the *ovaricæ* would seem to be an almost parallel case to a condition referred to by Gaupp as first observed by Nussbaum in the same arteries of the same species. But whereas the latter author states that the arteries ran in the primary members only of these "vier bis fünf weissliche Strahlen," and appears to have found them associated with the mesovarium generally, they were certainly in the present case connected with the arteries exclusively; for all of the *Aa. ovaricæ* were entirely enveloped by them, and, apart from the *Aa. ovaricæ*, there was no muscular thickening in the mesovarium. They had, in fact, the appearance only of a thick muscular investment of the arterial walls attached dorsally to the sides of the vertebral column.

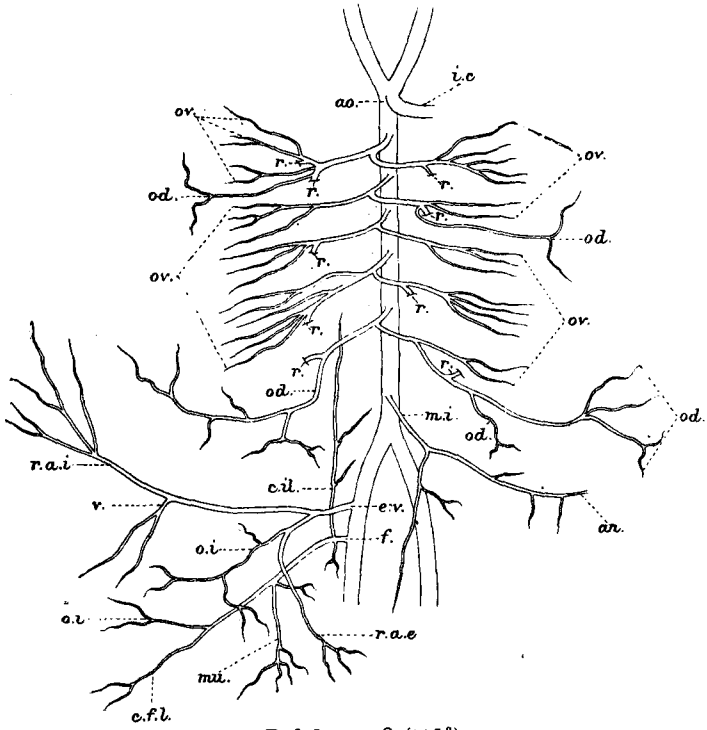
The *Aa. lumbales* were not followed sufficiently for purposes of comparison.

The *A. mesenterica inferior* was given off in all cases from the median ventral line of the aorta, between the last of the *Aa. urogenitales* and the bifurcation of the aorta. Between these two points its position varied considerably. It was close to the former in *R. clamata*, and very close to the latter in *R. hexadactyla*, a considerable space intervening in each case. It formed an anastomosis with the distal branch of the *mesenterica anterior* in *R. clamata*, *R. catesbiana*, and *B. boreas*, but not in the others, though this point is doubtless quite unimportant. Ordinarily it seems to be confined to the large intestine, running down to the cloacal region, but in *R. hexadactyla* two-thirds of the artery went to the oviducts.

The *A. epigastrico-vesicalis* showed a good deal of variation in the arrangement of its branches, but a division into three main portions was always apparent, and I am inclined to think that to divide this artery accordingly would be more satisfactory than its two-fold division by Gaupp into *recto-vesicalis* and *epigastrica communis*. For, owing to the tendency of the *A. recto-vesicalis* to arise between the two rami into which that author divides the *epigastrica communis*, the designation *epigastrica communis* to include these two rami is rendered of little value. While,

however, dissociating these two latter branches from any common origin, it is perhaps more desirable that I should here refer to them merely as the *r. abdominis externus* and *r. abdominis internus* respectively.

Text-fig. 151.



Bufo boreas, ♀ (× 1⅔).
Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

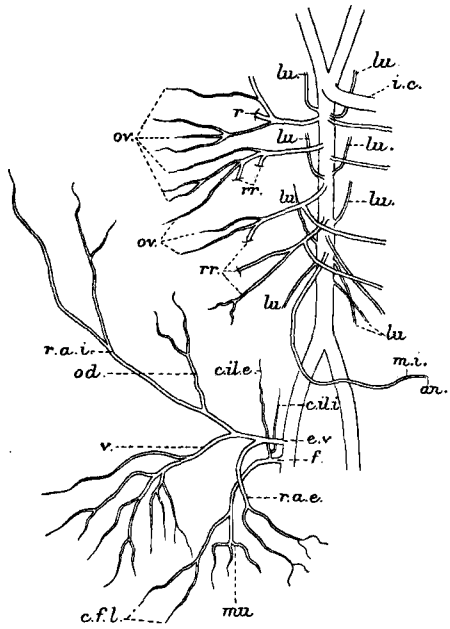
In *R. esculenta*, *R. catesbiana*, *R. clamata*, *B. boreas*, and *B. mauritanicus*, the first branch to arise was the *r. abdominis externus*, running down to the extreme base of the *M. rectus abdominis*, from which as a conspicuous vessel the *A. vesicalis ventralis* went in *R. catesbiana* to the allantoic bladder. In these cases, then followed the *A. recto-vesicalis*, its distribution being mainly or entirely to the bladder.

In *R. tigrina* and *R. hexadactyla*, on the other hand, the *recto-vesicalis* was given off before the *r. abdominis externus*, while in the latter species a small artery ran back first of all to the *M. coccygeo-iliacus* which was not observed in the others.

The *r. abdominis internus*, in all but *R. esculenta*, curved forwards over the *Mm. obliquus externus* and *obliquus internus*.

In *R. esculenta* this artery went to the oviduct, and appeared to give no branch at all to the muscles of the abdominal wall (text-fig. 150, p. 1024). In *R. catesbiana* it formed on the right side of the body a very distinct anastomosis with the fourth *r. abdominalis* of the *A. vertebralis dorsi*.

Text-fig. 152.



Rana clamata, ♀ (× 2).
Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

The *A. recto-vesicalis* arose by a single branch in all but *R. esculenta*, where it occurred as three separate offshoots from the main stem. In a specimen of *R. temporaria* the three branches of the *epigastrico-vesicalis* arose simultaneously.

The *A. femoralis* arose in all cases shortly after the above artery. In *R. hexadactyla*, on one side, the two were contiguous, though distinct from one another at their origins (text-fig. 149, p. 1023). The branches of this artery are subject to much variation in their arrangement and distribution, and there is some difficulty in comparing the species with one another. There was, however, in the

eight species under consideration a certain definite arrangement traceable which would seem to form a safe basis of comparison :—

Firstly, in all cases there was an *A. circumflexa ilium*, running directly forwards sooner or later from the main trunk of the *femoralis*, but the existence of two such arteries, arising independently, and distinguished by Gaupp as *interna* and *externa* respectively, I only found in *R. esculenta*. In all other cases, the single vessel was to be identified with the *A. circumflexa ilium externa* of that author. The *A. circumflexa ilium interna* was only represented by a branch or branches from this vessel, running to the *M. coccygeo-iliacus*; and I do not think that this artery will prove to have the value of an independent factor of the *A. femoralis* of the Anura generally. Secondly, there was in all the species an important branch running backwards and ventrally, chiefly to the muscles of the thigh. Thirdly, the outward continuation of the artery, more especially to the skin of the femoral region. The two latter branches I will refer to as the *A. muscularis* and the *A. cutanea femoris lateralis* respectively, preserving so far as possible the nomenclature of Gaupp, though the former includes a number of arteries separately named by him according to their division in the same region, while the latter may, either partly or entirely, strike out into a region other than that implied by its name. This arrangement of the branches of the *A. femoralis* was shown more typically in *R. esculenta*, *R. temporaria*, *R. hexadactyla*, *R. clamata*, and *B. mauritanicus* (text-figs. 149, 150, 152).

In *Bufo mauritanicus*, the *circumflexa ilium interna* was represented by a comparatively large branch of the *A. circumflexa ilium*, running inwards to the *M. coccygeo-iliacus*, and backwards to the cloaca; and in this species there was an additional branch from the base of the *A. cutanea femoris lateralis* to the *m. iliacus externus*. In *R. tigrina* the *cutanea femoris lateralis* was represented by an artery to the base of the *M. rectus abdominis*; while in *B. boreas* the same artery divided its supply between the *Mm. obliquus externus* and *obliquus internus* and the skin of the trunk. In *R. catesbiana* there were two additional branches: the first from between the *circumflexa ilium* and the *muscularis*, running to the skin of the femoral region; the second separating from the *cutanea femoris lateralis* and supplying the *Mm. rectus anticus femoris* and *ilio-psoas*, and also a recurrent branch (absent on the left side) from the *circumflexa ilium* to the *M. iliacus internus*.

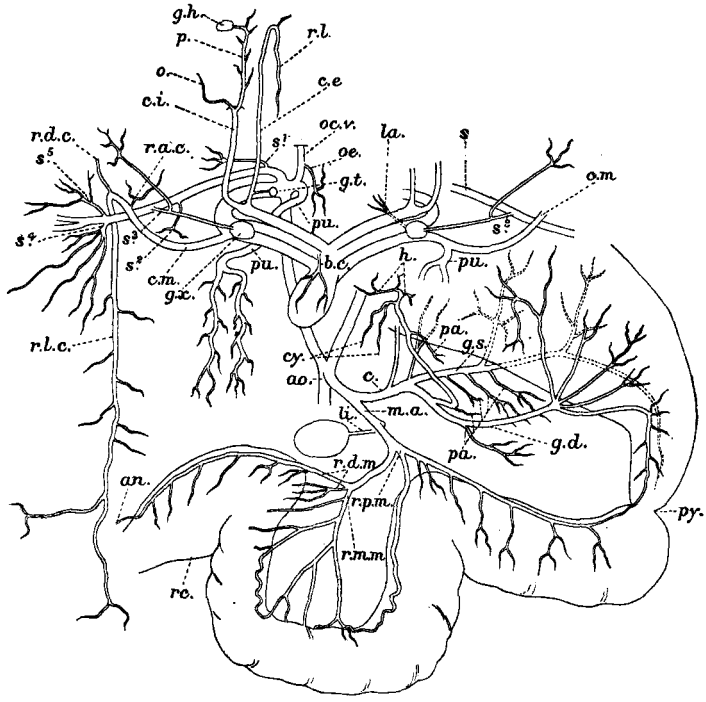
The *circumflexa ilium* originated proximally and before the *muscularis* in *R. temporaria*, *R. clamata*, *R. catesbiana*, *B. boreas*, and *B. mauritanicus*, and either opposite or distal to it in *R. hexadactyla*, *R. tigrina*, and *R. esculenta*.

III. Pulmo-cutaneous System.

A. cutanea magna.—The threefold division of this artery into *r. auricularis*, *r. lateralis*, and *r. dorsalis* occurred without much

variation in all but *R. hexadactyla*, where the first, which was not observed, may however have been possibly overlooked. The *r. auricularis* in *R. tigrina* subdivided to supply the tympanic membrane and the *Mm. depressor maxillæ, infraspinatus*, &c. In *R. clamata* and *R. catesbiana* it supplied more especially the tympanic region; in *B. mauritanicus* and *B. boreas* almost entirely so. In *R. catesbiana*, as previously stated, this vessel formed, on

Text-fig. 153.



Bufo boreas, ♀ (× 1⅓).

Portion of arterial system. Ventral view.

Showing abnormality of *A. pulmonalis* on the right side of the body.

s^1–s^5. Branches of *A. subclavia.*

s^1 to *M. levator anguli scapulæ.*

s^4 to *Mm. triceps brachii, pectoralis abdominalis,* and *subscapularis.*

(For other branches, see p. 1014. For explanation of other lettering, see p. 1033.)

the right side of the body, a complete union near its origin with a branch of the *A. subclavia*, presumably the *thoracica superior*. On the left side of the body it ran independently to the tympanic membrane, where it formed an anastomosis with a very small

twig thrown out to this region by the same branch of the *subclavia*.

A. pulmonalis.—After the separation of the *cutanea magna*, this artery generally divides into two branches, which further subdivide and break up into a thick interlacing network over the lung. But whereas in all the species of *Rana* under consideration these vessels traversed very conspicuously the outer surface of the lung, in both species of *Bufo*, while still external to the venous network, they traversed the inner wall in so marked a degree that it was necessary to cut open the lung to follow them at all.

In *Bufo boreas* (text-fig. 153, p. 1029) there was a very remarkable abnormality on the right side of the body in relation to the origin of the *pulmonalis*. The *cutanea magna* took off as usual from the end of the 3rd arch, opposite, roughly, to the carotid gland; the *pulmonalis*, however, was carried round in common with the systemic arch to the dorsal region as a single large trunk. Reaching the dorsal body-wall, first was given off the *subclavia*, secondly the *occipito-vertebralis*, and lastly the *pulmonalis*, separating from the aorta and descending again round the œsophagus to the lung. A closer investigation by means of a series of transverse sections cut through the arches, showed the true state of things to be that the third arch was concerned throughout with the *cutanea magna* exclusively, having no connection whatever with the *pulmonalis*. The latter simply ran in a common trunk with the systemic arch, in which there was no trace of a septum anywhere.

It is difficult to form a satisfactory inference as to how such a condition can have arisen in the embryo. The exclusive association of the posterior arch, from the outset, with the *cutanea magna* is wholly inconsistent with the generally accepted view that this artery originates, in common with the *pulmonalis*, from the fourth branchial arch of the embryo. On the other hand, the entire absence of any septum in the lumen of the systemic arch leaves little ground for supposing that the third branchial arch has persisted as the *pulmonalis*. It would appear that, under abnormal circumstances, in the embryo a connection had arisen irregularly between the second branchial arch and the lung, and had so persisted, the fourth branchial arch becoming simply the *cutanea magna* of the adult.

The normal arrangement of the pulmo-cutaneous arch on the left side of the body is shown in the figure of this Toad (text-fig. 153, p. 1029).

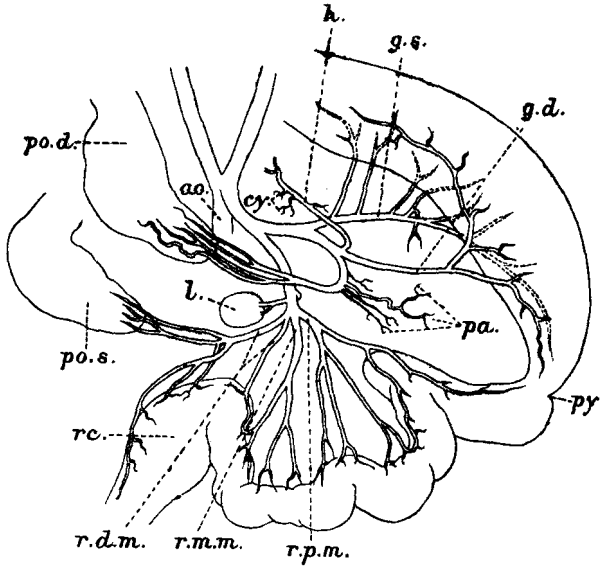
Appendix.

[On a direct Vascular Connection between the Mesenteric System and the Lungs in *Rana temporaria*. (Text-figs. 154, 155.)

While this paper was in the press, I received from Mr. W. Woodland a specimen of *Rana temporaria* exhibiting a very remarkable case of a connection between the mesenteric circulatory system and the lungs. Mr. Woodland, who lately observed

this Frog among a number of others that were being dissected by the students in the zoological class at King's College, London, very generously offered to send me the specimen for description, and I am much indebted to him for the opportunity of adding a short account of it here.

Text-fig. 154.



Rana temporaria, ♀ (× 2).

Ventral view of *A. intestinalis communis*, showing abnormal arteries to lungs. *l.*, spleen; *po.d.*, right lung; *po.s.*, left lung.

(For other lettering, see p. 1033.)

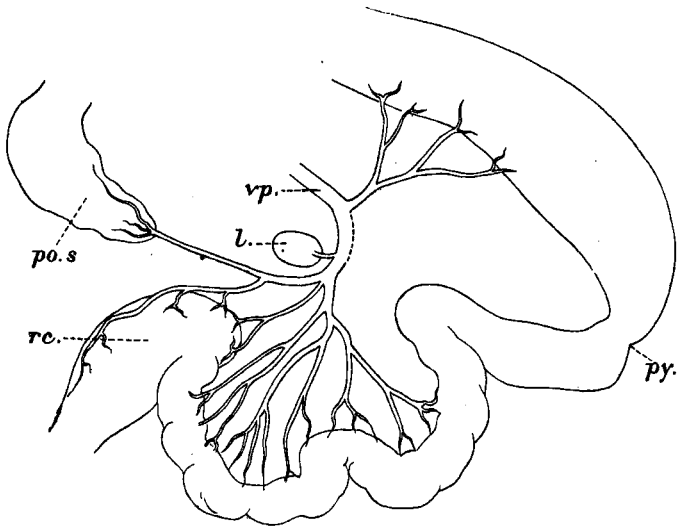
Examples of similar abnormality, recalling the conditions of the swim-bladder of Teleostean Fishes, have, as is well known, been several times observed in the Common Frog. Dr. E. Warren, when writing in 1902 (Zool. Anz. vol. xxv.), had himself noticed during the previous four years no less than five examples in about 200 individuals. Mr. B. B. Watson records a case in 1896 (Zool. Anz. vol. xix.). Mr. G. P. Mudge describes very fully (Journ. Anat. Phys. vol. xxiii.) a most remarkable instance, in which not only were both lungs involved in arterial and venous connection with the systemic circulation, but the *A. hepatica* was absent, its function being discharged by a branch from the left *A. pulmonalis*. In this latter example, a comparison is drawn by the author with the Ophidian type.

In Mr. Woodland's specimen, of which two figures are appended,

both lungs received apically a well-developed artery from the *A. intestinalis communis*, and one lung (the left) was in equally conspicuous connection with the hepatic portal vein. Both of the normal *Aa. pulmonales* were well developed. The *A. hepatica* appeared to be rather smaller than usual, but there was no connection between either of the *Aa. pulmonales* and the liver.

The abnormal vessels had the appearance on either side of a simple cord lying free in the body-cavity. There was no unusual extension of the mesentery. In the figures, the left lung is drawn out of position to avoid confusion.

Text-fig. 155.



Rana temporaria, ♀ (× 2).

Ventral view of hepatic portal vein (*vp.*), showing abnormal vein from left lung (*po.s.*). *l.*, spleen; *py.*, pylorus; *rc.*, rectum.

(The vein is left incomplete in the region of the dotted line owing to the omentum having been much torn at this point.)

The artery to the right lung originated in the *A. gastrica dextra* opposite to the *A. hepatica*, and was about equal in size to the *gastrica dextra* immediately beyond the point where the *hepatica* was given off. It distributed four vessels to the pancreas and then about half way to the lung divided into two branches, each of which divided again before reaching the apex of that organ. There was no vein returning to the mesentery from this lung.

The artery to the left lung arose from the *distal ramus* of the *A. mesenterica anterior*. This ramus first gave off a single vessel to the proximal point of the large intestine and then, some distance further on, the pulmonary artery separated from the

remainder. The pulmonary portion at once bifurcated and the posterior branch of it immediately afterwards gave back a small vessel to the rectum which crossed the rectal artery dorsally. The same branch divided again before reaching the lung; the other did not.

The vein from this lung was about equal in bulk to the two arterial branches combined. It left the apex of the lung as a single vessel, and entered the extreme rectal branch of the *vena portæ* at a point almost coincident with the origin of the pulmonary artery. It was wrapped up closely with the two branches of the latter in a simple peritoneal sheath, so closely, that it required the greatest care in dissection to ascertain the true arrangement of the vessels; and the same was the case in the arteries of the right lung, the separating out of the component factors being only due to the necessity of so figuring them.

It is to be observed in the present instance that the two arteries commence early to subdivide, and produce between them no less than seven branches before reaching in either case a point at the apex of the lung where the branches are still practically non-divergent. In the circumstances, the occurrence of such a consistent process of division within an extremely narrow compass seems to deserve particular notice from an ontogenetic point of view, suggesting the interpretation that the arteries themselves show a predisposition to revert to a remotely ancient type in which such division was necessitated by the character and extent of their destination in the swim-bladder.

In view of the present and similar examples, the question is to be considered whether the abnormality described above in *Bufo boreas* may not fall within the same category as representing an intermediate condition such as that exhibited in the Dipnoan fish *Protopterus*, where the pulmonary arteries have a very similar origin.

Plymouth, Feb. 17th, 1907. L. R. CRAWSHAY.]

LETTERING OF TEXT-FIGURES.

an. Anastomosis between *Aa. mesenterica anterior* and *mesenterica inferior.*
ao. Aorta.
b.c. *A. bulbi cordis.*
c. *A. cœliaca.*
c.a. Artery to *Corpora adiposa.*
c.c. *A. carotis externa.*
c.h. Artery to *M. coraco-humeralis.*
c.i. *A. carotis interna.*
c.il.e. *A. circumflexa ilium externa.*
c.il.i. *A. circumflexa ilium interna.*
c.f.l. *A. cutanea femoris lateralis.*
c.m. *A. cutanea magna.*
co.i. Artery to *M. coccygeo-iliacus.*
cu.h. Artery to skin of upper arm.
cu.p. Artery to skin under pectoral girdle.
cy. *Aa. cysticæ.*
ev. *A. epigastrico-vesicalis.*

f. *A. femoralis.*
g.d. *A. gastrica dextra.*
g.h. *Glandula harderi.*
g.t. *Glandula thyroidea.*
g.s. *A. gastrica sinistra.*
g.x. Problematical gland (?).
h. *A. hepatica.*
i. Artery to *M. infraspinatus.*
i.c. *A. intestinalis communis.*
i.c.s. Artery to *M. intertransversarius capitis superior.*
i.sc. Artery to *M. interscapularis.*
l.a.s. Artery to *M. levator anguli scapulæ.*
l.d. Artery to *M. latissimus dorsi.*
la. *A. laryngea.*
li. *A. lienalis.*
lu. *Aa. lumbales.*
m.a. *M. mesenterica anterior.*
m.i. *M. mesenterica inferior.*
mu. *Aa. musculares* of *A. femoralis.*
o. *A. ophthalmica.*
o.i. Branch of *A. epigastrico-vesicalis* to *M. obliquus internus.*
o.i. (in figs. 143, 144). Branch of *A. subclavia* to *M. obliquus internus.*
o.n. *A. orbito-nasalis.*
oc.v. *A. occipito-vertebralis.*
od. *Aa. oviductus.*
œ. *A. œsophagea.*
ov. *Aa. ovaricæ.*
p. *A. palatina.*
p.a. Artery to *M. pectoralis abdominalis.*
p.s. Artery to *M. pectoralis sternalis* (through coracoid foramen).
pa. *Aa. pancreaticæ.*
pu. *A. pulmonalis.*
py. Pylorus.
r.r. *Aa. renales.*
rc. Rectum.
re. Branch of *A. mesenterica inferior* to rectum.
r.a.c. *Ramus auricularis* of *A. cutanea magna.*
r.a.e. *Ramus abdominis externus* of *A. epigastrico-vesicalis.*
r.a.i. „ „ *internus* „ „ „
r.d.c. *Ramus dorsalis* of *A. cutanea magna.*
r.d.m. Distal ramus of *A. mesenterica anterior.*
r.f.a. Branch of *A. cutanea femoris lateralis* to *M. rectus femoris anticus.*
r.l. *Ramus lingualis* of *A. carotis externa.*
r.l.c. *Ramus lateralis* of *A. cutanea magna.*
r.m. *Ramus muscularis* of *A. carotis externa.*
r.m.g. *Ramus musculo-glandularis* of *A. carotis externa.*
r.m.m. Median ramus of *A. mesenterica anterior.*
r.mx.i. *Ramus maxillaris inferior* of *A. occipito-vertebralis.*
r.mx.s. „ „ *superior* „ „
r.p.m. Proximal ramus of *A. mesenterica anterior.*
r.v. *A. recto-vesicalis.*
s. *A. subclavia.*
s^1–s^9. Rami of *A. subclavia.*
s.sc. Artery to *M. subscapularis.*
sc. Artery to scapula.
sp. *Aa. spermaticæ.*
t.b. Artery to *M. triceps brachii.*
$t.s.^1$ „ „ *M. transverso-scapularis major.*
$t.s.^2$ „ „ „ „ *minor.*
v. *A. vesicalis.*
III. Artery to 3rd spinal nerve.